

University of Warwick institutional repository: <http://go.warwick.ac.uk/wrap>

A Thesis Submitted for the Degree of PhD at the University of Warwick

<http://go.warwick.ac.uk/wrap/4154>

This thesis is made available online and is protected by original copyright.

Please scroll down to view the document itself.

Please refer to the repository record for this item for information to help you to cite it. Our policy information is available from the repository home page.

9

Policy Evaluation with Macroeconometric Models

Silvia Sgherri

A thesis submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy in Economics



University of Warwick, Department of Economics

July, 2000

Contents

<i>List of Figures</i>	iii
<i>List of Tables</i>	iv
<i>Acknowledgments</i>	v
<i>Declaration</i>	vii
<i>Abstract</i>	viii
CHAPTER ONE	
INTRODUCTION	1
PART ONE: SMALL STYLISTED MODELS	16
CHAPTER TWO	
INFLATION TARGET BANDS AND THE 'FAIRLY SUBSTANTIAL LUMP OF INFLATION UNCERTAINTY' IN THE UK	17
2.1 INTRODUCTION	17
2.2 THE HALDANE-SALMON MODEL	24
2.3 A REVISED AND EXTENDED MODEL	29
2.4 CONCLUSIONS	34
APPENDIX A: THE ESTIMATES	36
APPENDIX B: COMPUTING ASYMPTOTIC FORECAST VARIANCES IN A LINEAR RE MODEL	39
CHAPTER THREE	
WAGES, PRICES AND INFLATION-OUTPUT VARIANCE TRADE-OFFS: MORE ON INFLATION TARGETRY IN THE UK	43
3.1 INTRODUCTION	43
3.2 MODELLING WAGES AND PRICES	49
3.2.1 The price equation	49
3.2.2 The wage equation	51
3.2.3 Other equations	55
3.3 INFLATION TARGETRY	58
3.3.1 Policy rules	58
3.3.2 Model properties	59
3.3.3 The variance of inflation and output	62
3.4 CONCLUSIONS	70
APPENDIX	72
PART TWO: A LARGE-SCALE COUNTRY MODEL	73
CHAPTER FOUR	
MONETARY TRANSMISSION CHANNELS, MONETARY REGIMES AND CONSUMPTION BEHAVIOUR	74
4.1 INTRODUCTION	74
4.2 TRANSMISSION MECHANISMS AND CONSUMPTION MODELS	78
4.2.1 Monetary transmission channels	78
4.2.2 The 'disposable funds' approach	83
4.2.3 A modified 'life-cycle permanent-income' approach	84
4.3 NIDEM: MAIN FEATURES	88
4.3.1 The demand side	89
4.3.2 The supply side	90

4.3.3	<i>The monetary stance</i>	91
4.3.4	<i>The fiscal stance</i>	92
4.4	THE SIMULATION EXPERIMENT	93
4.4.1	<i>The design</i>	93
4.4.2	<i>The financial structure</i>	95
4.4.3	<i>Macroeconomic responses following a monetary loosening</i>	99
4.4.4	<i>Decomposition of transmission channels for selected scenarios</i>	108
4.5	CONCLUSIONS	118

PART THREE: A MULTI-COUNTRY MODEL 121

CHAPTER FIVE

THE FISCAL DIMENSION OF A COMMON MONETARY POLICY..... 121

5.1.	INTRODUCTION	121
5.2.	MULTIMOD MARK III: MAIN FEATURES.....	125
5.3.	THE SIMULATION EXPERIMENT.....	125
5.3.1.	<i>The baseline scenario</i>	125
5.3.2.	<i>The design</i>	128
5.4.	RESULTS	130
5.4.1.	<i>A common monetary policy</i>	130
5.4.2.	<i>A common degree of debt monetisation</i>	134
5.4.3.	<i>Strict enforcement of the Stability and Growth Pact</i>	140
5.4.4.	<i>Increasing efficiency in credit market</i>	144
5.5.	CONCLUDING REMARKS.....	146
	APPENDIX	148

CHAPTER SIX

WHEN IS LABOUR MARKET FLEXIBILITY WELCOME? MORE ON ASYMMETRIC POLICY IMPACTS IN EUROPE..... 153

6.1	INTRODUCTION.....	153
6.2	THE TOOL OF ANALYSIS: MULTIMOD MARK III.....	162
6.2.1	<i>A convex Phillips curve model</i>	162
6.2.2	<i>Modelling alternative monetary policy regimes for Europe</i>	167
6.3	SIMULATION RESULTS.....	170
6.3.1	<i>Asymmetric policy responses under different monetary regimes for Europe</i>	170
6.3.2	<i>Do initial conditions matter?</i>	183
6.3.3	<i>Increasing flexibility in European labour markets: winners and losers</i>	187
6.4	CONCLUDING REMARKS	193
	APPENDIX	195

CHAPTER SEVEN

CONCLUSIONS..... 200

REFERENCES..... 208

List of Figures

Figure 2.1: Annual inflation for Sweden and the UK (percentage points) 22

Figure 3.1 Disinflation experiment under difference and level rule..... 61

Figure 3.2. Inflation-output standard error trade-offs under contemporaneous inflation-only rules 64

Figure 3.3 Inflation-output standard error trade-offs under
1-quarter forward-looking inflation-only rules..... 64

Figure 3.4 Inflation-output standard error trade-offs under
2-quarter forward-looking inflation-only rules..... 64

Figure 3.5 Inflation-output standard error trade-offs under backward-looking wage bargaining 65

Figure 3.6 Inflation-output standard error trade-offs under
1-quarter forward-looking wage bargaining..... 65

Figure 3.7 Inflation-output standard error trade-offs under
2-quarter forward-looking wage bargaining..... 65

Figure 3.8 Inflation standard errors as a function of target rule parameters..... 67

Figure 3.9 Output standard errors as a function of target rule parameters 67

Figure 3.10 Map of inflation-output standard error trade-offs under fixed μ and varying λ 69

Figure 3.11 Map of inflation-output standard error trade-offs under fixed λ and varying μ 69

Figure 4.1: Monetary variables responses under a ‘disposable funds’ approach.....96

Figure 4.2: Monetary variables responses under a ‘life-cycle’ approach97

Figure 4.3: Unemployment vs. inflation responses to a monetary loosening.....104

Figure 4.4: Contribution to GDP changes by transmission channel.....116

Figure 4.5: Contribution to consumption changes by transmission channel117

Figure 5.1: Deflation experiment within EMU-3 - Reducing aggregate money target by 5% 133

Figure 5.2: GERMANY - Deflation experiment within EMU-3
under common seigniorage revenues 137

Figure 5.3: FRANCE - Deflation experiment within EMU-3 under common seigniorage revenues 138

Figure 5.4: ITALY - Deflation experiment within EMU-3 under common seigniorage revenues..... 139

Figure 5.5: ITALY - Deflation experiment within EMU-3
under common seigniorage revenues and strict enforcement of the SGP..... 143

Figure 5.6: ITALY - Deflation experiment within EMU-3 under common seigniorage revenues,
strict enforcement of the SGP and increased efficiency in credit market..... 145

Figure 5.7: Implications of common seigniorage revenues for Germany and Italy: phase diagram .. 150

Figure 5.8: Implications of enforcing SGP criteria for Italy: phase diagram 152

Figure 6.1 Implications of employing a non-linear model of the Phillips curve 166

Figure 6.2 Implications of a shift of the Phillips curve down and to the left..... 167

Figure 6.3 Implications of increasing flexibility in German and Italian labour markets..... 192

List of Tables

Table 2.1 Forecast standard errors of inflation (percentage points per annum)	32
Table 2.2: IS equation	36
Table 2.3: LM equation	36
Table 2.4: Cost mark-up pricing equation	37
Table 2.5: Wage-bargaining equation	37
Table 2.6: Import price equation	38
Table 3.1 Domestic price inflation equation	50
Table 3.2 Earning inflation equation	52
Table 3.3 Output gap equation	55
Table 3.4 Import price inflation equation	57
Table 3.5 Uncovered Interest Parity equation	57
Table 4.1: Macroeconomic responses under a 'disposable-fund' consumption function	100
Table 4.2: Macroeconomic responses under a 'life-cycle' consumption function	106
Table 4.3: Decomposition of transmission channels (scenario 1a)	112
Table 4.4: Decomposition of transmission channels (scenario 2a)	113
Table 4.5: Decomposition of transmission channels (scenario 1b)	114
Table 4.6: Decomposition of transmission channels (scenario 2b)	115
Table 5.1: Okun's Law and Phillips Curve parameter estimates	126
Table 5.2: Parameter estimates of the consumption model	130
Table 5.3: Country-specific steady-state budgetary positions	124
Table 5.4: MM3 baseline forecasts	127
Table 6.1 Okun's Law and Phillips Curve parameter estimates	163
Table 6.2 Uncoordinated national monetary targeting regimes	172
Table 6.3 The ERM monetary regime	177
Table 6.4 The EMU monetary regime	182
Table 6.3 The EMU monetary regime under disequilibrium conditions	186

Acknowledgments

There are many persons who have contributed to the fulfilment of this project, both on a professional and on a personal level. First and foremost professional influence has been my supervisor, Kenneth Wallis. I thank him not only for his flexibility and accessibility throughout my postgraduate studies, but also for his incredible support and encouragement whenever needed. My special thanks are for another - former but not less important for my professional choices - supervisor: Carlo Bianchi. To them, I owe any interest and knowledge I have in macroeconomic modelling.

I would also like to thank the members of the Department of Economics at the University of Warwick, in particular Marcus Miller, and my (at that time) colleagues at the ESRC Macroeconomic Modelling Bureau. Together, they have created a fruitful atmosphere for research. Besides, I am especially grateful to Liz Thompson, who provided an invaluable secretarial assistance.

Needless to say, I owe a great deal to the ‘Wetenschappelijk Onderzoek en Econometrie’ (or, much more easily, WOE) Department of De Nederlandsche Bank and each one of my (current) colleagues. They allowed me to carry out the third part of my research in such a pleasant and friendly working environment that any acknowledgement would hardly be enough to express my thankfulness. Without their hospitality, help and (also financial) support this thesis would have never been finished.

A thesis, however, requires more than only professional inputs. In this respect, I would like to thank my dearest friends, Ludo&Lore, Memme, Manu, Cri, Lo, Marco, Angy&Gigi, for their constant trust in me and their patience in putting up with my ups and downs. I am also grateful to all the friends I met in Warwick, with a particular mention to Chuy, who shared with me both inspired and uninspired moments during the past two years. But above anyone else, I am indebted to my parents, who paid the highest price for this thesis: the distance which has kept us apart for such a long time.

Declaration

The introduction draws heavily from the introductory discussion on the use of macromodels for policy analysis in the joint paper by Ken Wallis and myself ‘Policy Analysis with Macroeconometric Models: Inflation Targetry in a Small Structural Model’, presented in Paris at the ADRES/CEPREMAP conference ‘The Econometrics of Policy Evaluation’, 10-12 January 2000.

Chapter 2 is based on the joint paper by Ken Wallis and myself ‘Inflation Target Bands and the Bank of England’s ‘Fairly Substantial Lump of Inflation Uncertainty’’, ESRC Macroeconomic Modelling Bureau, discussion paper no. 49, October 1997. The paper has benefited from discussions with participants of the HMT Academic Panel in London, March 1998, and of the Royal Economic Society in Warwick, April 1998.

Chapter 3 is a revised version of the joint paper by Ken Wallis and myself ‘Inflation Targetry and the Modelling of Wages and Prices’. The paper has benefited from discussions with members of the Department of Economics, University of Warwick, and from comments by participants of the ESRC Macromodelling Bureau Seminar in Warwick, July 1999, and of the Econometric Society European Meeting in Santiago, August 1999.

An earlier version of Chapter 4 has appeared with the same title in ESRC Macroeconomic Modelling Bureau, discussion paper no. 54, September 1999. It has been improved by the comments made by my colleagues at the ESRC Macromodelling Bureau and members of the Department of Economic Research and Special Studies of De Nederlandsche Bank.

Chapter 5 and 6 have been written while I was research fellow at the Department of Economic Research and Special Studies of De Nederlandsche Bank. A forerunner of chapter 5 has appeared in De Nederlandsche Bank, Research Memorandum WO&E no. 615, April 2000, and has been presented in Frankfurt at the European Central Bank, 16 March 2000; in Glasgow at the University of Strathclyde, 11 May 2000; in Venice at the Joint International Meeting ‘EURO: What’s in the Future?’, 8-9 June 2000; in Warwick at the Macromodelling Seminar, 3-5 July 2000. An earlier version of chapter 6 has also appeared in De Nederlandsche Bank, Research Memorandum WO&E no. 619, May 2000 and has benefited from comments by Ken Wallis, Peter van Els and Andrew Hughes-Hallett.

Abstract

This thesis presents a number of examples where macroeconometric models are employed as useful tools for evaluation of contemporary policy problems. A range of approaches is proposed to shed light on how macromodels can actually contribute to the policy debate. In particular, the thesis emphasises how different models maybe augmented or modified and stresses the need for care in the experimental design of policy simulations.

Small stylised models of the UK economy are estimated in the first part of this thesis. They are used to assess the performance of simple monetary policy rules under the current inflation targeting monetary regime. In a monetary policy regime of inflation targeting, the appropriate target band-width can be assessed by calculating the variance of inflation in a macroeconomic model under alternative policy rules. A recent Bank of England study concludes from stochastic simulation of a small semi-structural model that a 'fairly substantial lump of inflation uncertainty' exists in the United Kingdom. In chapter 2 an extended and improved version of that model is developed while their estimates of inflation variability are revised downwards by deploying analytic techniques. In chapter 3 a new small 'semi structural' dynamic model of the UK economy is estimated, with particular attention to the modelling of wages and prices. It is used to assess the performance of simple monetary policy rules, including 'inflation forecast targeting' and 'Taylor' rules, while taking into account different degrees of forward-lookingness in both inflation targeting horizon and wage bargaining. Computation of asymptotic inflation-output standard-error trade-offs is provided under various specifications and parametrisations of the model.

Large-scale country models have the convenience to make explicit a complete range of relationships among macroeconomic variables most of which, for obvious reasons, are neglected in smaller dynamic models. As a consequence, such quantitative framework offers an unique opportunity to evaluate not only the aggregate impact of exogenous shocks on the variables of interest, but also to identify the underlying economic mechanisms enabling the transmission of such shocks. In the second part of the thesis, I undertake simulations of the National Institute's Domestic Econometric Model (NIDEM) to analyse the characteristics of the UK monetary transmission mechanism. Chapter 4 emphasises that the impact of interest rate movements on real variables is strictly determined by both the monetary regime at work and the underlying assumptions regarding consumption behaviour.

Certainly, the steady integration of the members of the EMU and increasing awareness of the need for closer co-operation in monetary and fiscal policy have stimulated greater interest in modelling interdependencies between European countries and the impact and feedbacks from the rest of the world economy. Many of the key issues have now an international aspect, so it becomes more and more difficult to rely on single-country models to provide necessary analysis. International transmission mechanisms can therefore be better tackled with a multi-country model. The third and last part of this thesis focuses on cross-country asymmetric transmissions in response to a common monetary shock within EMU. In particular, in chapter 5 an empirical analysis of the links between monetary and fiscal policy within EMU is presented. This is done through simulation of a neo-classical highly non-Ricardian multi-country model: the IMF's MULTIMOD Mark III (MM3). Chapter 6 provides further evidence about the effects of embracing a Monetary Union when underlying macroeconomic structures still differ across countries. By use of the same model-based quantitative framework, this chapter examines the role of nominal and real rigidities in European labour markets for the assessment of asymmetries in monetary transmission under various monetary regimes.

Chapter One

Introduction

Writing about ‘policy evaluation with macroeconomic models’ certainly has an old fashion – almost romantic – flavour. It was before the mid 1970s that large macroeconomic models were still playing a central role in the policy debate. These models were used both for forecasting and policy simulation exercises, typically with short-run horizons of between eighteen months and two years. They shared a common underlying economic paradigm, namely a basic Keynesian income-aggregate demand framework with little or no role for supply-side factors. Their long-run properties and consistency with theory were rarely questioned. Because of their inherent similarities, it is not hard to believe that these macromodels failed at approximately the same time. Thus, by the early 1980s, policy-makers lost their confidence in the use of macromodelling for policy in general, probably also because expectations of what models might achieve had been set too high, with unrealistic claims about their reliability and scope.

There were broadly two reasons for the disenchantment with the demand-oriented macroeconomic models of the 1970s and their use for policy evaluation, design and optimisation. The first was their forecasting breakdowns in the face of supply-side shocks, that could not be made to fit into the existing analytical framework. The major failures came

after the first oil shock and the widespread expansionary fiscal policies at the beginning of the 1970s, when macromodels could not explain associated stagflation phenomena, with rise (and persistence) of both inflation and unemployment. The inflationary mechanism in the models was based around a Phillips curve that was downward-sloping, even in the long run. Problems in finding a stable econometric relationship meant that wages were often treated as exogenous in both forecasting and policy analysis. The exchange rate was treated in much the same manner, because of the lack of data on a flexible exchange rate regime. In this way two of the main transmission mechanisms of shocks to inflation were essentially ignored and inflation was consistently underestimated in that period. The second reason of the mistrust was the perceived theoretical inadequacy of the models. Criticism of their lack of internal consistency and consequent quest for sensible microfoundations came especially from the 'new classical' school of economic thought, both the monetary variants associated with Lucas, Sargent, Wallace and Barro, and the real business cycle variant of Kydland, Prescott and others.

Developments in econometric methods have also contributed to substantial improvements in macromodelling in the last two decades. Considerable use has been made of the dynamic specification known as the error-correction model. The error-correction model has provided a convenient representation of the long-run implications of a dynamic model, where comparative static economic theory is more relevant, together with a more data-based specification of the process of short-run adjustments.

As a result of such criticisms and evolutions, a new paradigm has emerged in macroeconometric modelling. It allows for the co-existence of a neo-classical view of macroeconomic equilibrium with a new Keynesian view of short-to-medium-term adjustment. Accordingly, short-term fluctuations in output are largely led by changes in the components of aggregate demand, whereas the long-run properties of the model are determined by the broad predictions of the neo-classical model of growth. In this way, any medium-to-long-term output response is primarily shaped by (exogenous) supply-side factors, through technical progress and population growth. This implies that, at least in respect of the long-run

equilibrium, the level of real activity is independent of the price level and the steady-state inflation rate. Nonetheless, in the short run, adjustment costs and contractual arrangements prevents markets from clearing, inducing considerable output inertia and employment disequilibria.

The core supply-side is nowadays pivotal in defining model properties, not only because the corresponding variables' dynamic responses determine the outcome for price inflation, but also because the long-run solution to these equations can be used to derive an expression for the equilibrium rate of unemployment (Joyce and Wren-Lewis, 1991; Turner, 1991; Wren-Lewis, 1997). In particular, if the implicit aggregate supply curve is vertical in the long run, wage and price equations can be combined to form an expression for the NAIRU, the non-accelerating inflation rate of unemployment. For this to exist, equations for average earnings and prices in the good markets should exhibit both static and dynamic homogeneity, that is money neutrality and superneutrality (Carlin and Soskice, 1990; Layard *et al.*, 1991).

The other breakthrough in macroeconomic modelling has certainly been the advent of the rational expectations hypothesis. In a model embedding anticipation of future endogenous variables, the long-run effects of exogenous shocks may also be important determinants of short-run behaviour and their influence has been incorporated into macroeconometric models in various ways. A common way of dealing with unobserved expectations variables was to assume that they are functions of the current and lagged values of a few observed variables, the simplest example being the adaptive expectations hypothesis. The unobserved expectations variables are then substituted out, giving a conventional backward-looking dynamic or distributed lag model. This confounds the description of economic behaviour given expectations. This way of representing expectations formation is subject to the Lucas critique (1976) according to which behavioural equations are unlikely to remain invariant across policy regimes and hence likely to give wrong estimates of the macroeconomic consequences of a change in policy regime. This critique has been questioned by arguing that model-based policy analysis often evaluates the consequences of changes in the settings of

policy instruments, rather than complete regime shifts. Nonetheless, macromodellers have eventually accepted 'the critique' by assuming that expectations are formed 'rationally'. In this manner, it is actually possible to keep the description of the formation of expectations separate from the model of economic behaviour given expectations. The rational expectations hypothesis assumes that expectations coincide with the conditional expectations of the variable in question, given 'all available information', which includes knowledge of the underlying economic system. Its foundation in optimising behaviour led to its incorporation into equilibrium business cycle models, while its advocacy as part of 'new classical' macroeconomics, and the hostility in the United States to the 'policy ineffectiveness' propositions of that school of thought may explain why it was not widely embraced in US mainstream models. Elsewhere the distinction between the theoretical stance of the model in which expectations variables appear and the theory of expectations which is adopted was more immediately appreciated. In the United Kingdom, for example, the rational expectations hypothesis had been incorporated into mainstream models by the mid-1980s.

The practical solution of a model for the endogenous variables over a forecast period requires an internally consistent forward-looking solution sequence to be calculated, whereby each period's expectations coincide with the model's forecasts for the future period. With this implementation the approach is more accurately and perhaps less controversially termed 'model-consistent' expectations. The computational cost of solving rational expectation models, is higher than that of backward-looking dynamic models. It is possible to derive an analytic expression for the solution of linear models, and consider its uniqueness and stability, usually referred to as a saddlepoint path (Blanchard and Kahn, 1980). Nonlinear models, on the other hand, are no longer solvable by using period-by-period numerical solution techniques appropriate for backward-looking models; what is required, at least conceptually, is iterating over the complete solution path (Juillard *et al.*, 1998). Furthermore, and in parallel to the requirement for initial conditions when solving conventional difference equations, there is also a need for terminal or transversality conditions that specify forecast values and

expectations for the forecast horizon. If the steady-state properties of the model are known, then the terminal conditions may incorporate this information explicitly. In the IMF's MULTIMOD Mark III model, for example, each of the dynamic equations has a steady-state analogue equation, which is used (collectively) to determine model-consistent terminal conditions. The steady-state and dynamic model are solved simultaneously, to derive first the terminal conditions for the forward looking variables, and second the dynamic baseline of the model (Laxton *et al.*, 1998). This has the added feature that the terminal conditions are not fixed, but are determined by the shocks applied in experiments. The advantage of this endogenous procedure is that it facilitates convergence and prevents huge jumps during the last periods, necessary to revert the model to its terminal values. A relatively long solution period may be required however, to ensure that the model has reached an approximate equilibrium. In the absence of such knowledge, or in a shorter solution period, terminal conditions are typically specified to approximate a saddlepoint path by requiring constant growth rates for the relevant variables.

The rational expectations hypothesis adds a further dimension to model-based policy analysis. In estimating the consequences of a change in a policy instrument, the 'all available information' assumption described above allows a distinction between anticipated and unanticipated changes to be drawn. For example, if a shock is anticipated in a model with explicit future expectations, then it is possible to observe some response prior to its occurrence. And introducing the shock at an intermediate point of the solution period, while solving over the whole period, can allow for the dynamic effects of such anticipations. If on the other hand, a shock is unanticipated, no such prior response occurs and the immediate and subsequent responses can be estimated by introducing the shock at the beginning of the solution period. This is what is conventionally done in backward-looking models, where there is no point in delaying the introduction of a shock.

The full information assumption may be inappropriate or unacceptable in some circumstances, and various hybrid ways of treating expectations have resulted. Empirical analysis of observed

expectations or forecasts does not always find them to be unbiased and efficient, as predicted by the rational expectations hypothesis (Brown and Maital, 1981). Moreover, the use of rational expectations techniques for policy analysis presumes severe information requirements on the private sector. Namely, they need to know not only the true underlying model, but they also need to know how to solve the model. This may not be wholly realistic but it might be taken as a simple 'as if' assumption. The more serious objection to the consistent expectations solution is instead related to the very sudden and sharp response of forward-looking 'jump' variables to new information. Practically, it seems unlikely that the full implications of any announced policy change feed through into the forward-looking jump variable so quickly, completely and correctly. Since theory itself is not at question, the implausibility of the large responses arises from the total belief that the policy will really occur at time T as announced. This is true only if we assume that policymakers enjoy credibility for precommitment to any announced policy change. In attempting to capture a model of expectation formation which falls between the two undesirable extremes of reduced form adaptive expectations, on the one hand, and full model consistent expectations, on the other, various kinds of learning mechanisms have been developed in the literature, sometimes with respect to the model itself and sometimes with respect to its external environment. Although learning mechanisms are not yet a standard part of the model builders armoury, 'adaptive learning' approach has been used regularly at the London Business School (Garratt and Hall, 1992), while Westaway (1992) presents an implementation of 'rational learning' in a large-scale macromodel for policy credibility analysis. Intermediate cases between adaptive and rational expectations also include expectations based on small VAR models, perhaps designed to mimic some dynamic characteristics of the macroeconometric model. In these exercises the rational expectations assumption often continues to serve as a baseline, not only in the sense that many of the learning schemes are designed to converge on the full information scenario, but also as a comparator for the alternative solution trajectory, allowing the gains from the full credibility of policy to be evaluated, for example.

The common backward-looking treatment of expectations may have also contributed, in the past, to the neglect of asset stock equilibria, as a debt explosion in the remote future does not have any effect on short-term forecasts in an 'adaptive' world. The introduction of forward-looking behaviour, for exactly the opposite reason, forced the intertemporal government budget constraint onto the policy modelling agenda. The debt explosion in many OECD countries in the 1980s also provoked similar reaction. Although the classic article by Christ (1968) drew attention to the importance of the government budget constraint and the implication of assuming different sources of deficit financing, in the absence of complete stock-flow accounting the debt stock position was often not monitored. Initial developments occurred in multi-country models, led by Paul Masson and colleagues at the IMF, and different ways of incorporating the constraint appear in several models featuring in the multi-country model comparison projects sponsored by the Brookings Institution (Bryant *et al.*, 1988, 1993). The Maastricht Treaty's fiscal requirements were an additional reason for many European national-economy modellers to follow suit.

The intertemporal government budget constraint, ensuring that policy remains sustainable, is represented as a stability condition for the debt/GDP ratio and/or deficit/GDP ratio. The ratio form reflects both the definition of a steady state in terms of constant real and nominal growth rates, and the practical expression of the Maastricht targets. The period-by-period government budget constraint is silent on the question of which of the government's income and expenditure variables should be adjusted in the face of a disequilibrium - it is an identity, not a behavioural equation. In practice, model-based analyses take tax revenues or the average tax rate to be the relevant policy instrument. Equally, the solvency requirement does not specify the time path of any necessary adjustment, but simply that an adjustment must occur, sooner or later. Again, in practice, adjustment is assumed to take place continuously, by specifying a policy rule or reaction function that describes how the instrument is altered period-by-period in response to deviations of the target variable from its desired value. Nevertheless different formulations appear in different models - tax levels or first differences, debt or deficit targets -

resulting in the suspicion that these differences contribute to observed differences in simulation results. Recent research (Mitchell *et al.*, 2000) has established equivalences between these rules, in respect of both their long-run equilibria and their disequilibrium dynamics, which will assist both the design of the rules and the interpretation of results.

Shifts in policy making were certainly crucial in modifying macromodels' features. As a consequence, policy evaluation procedures have also advanced considerably. Traditional policy analysis with macroeconometric models consisted of 'what-if' exercises, addressing the question, what would be the macroeconomic consequences if policy settings, treated as exogenous, were altered. A more recent tendency has been a move away from an exogeneity assumption towards an endogenization of policy or 'closing' of the model, using a variety of techniques ranging from simple feedback rules to full optimization. To some extent the challenge of VAR modellers, who from the beginning abandoned the endogenous/exogenous distinction, provoked this response, while other important stimuli were the changes in practical policy-making, both fiscal and monetary.

Optimal control theory has provided an important foundation for methodological developments in policy analysis, although it has seldom featured in practical policy-making, due to the difficulty of specifying a practical objective function. The basic theoretical result is that, if the objective function or loss function is a quadratic function of the deviation of outcomes from their target values and the model is linear, then the optimal (minimum expected loss) settings of policy instruments are given by linear feedback rules. These can be rather complicated, however, since all 'state' variables appear in the rule, and one question has concerned the trade-off between optimality and simplicity. Extensions to nonlinearity and/or forward-looking expectations have also studied simple linear rules in comparison with full optimisation, noting that in this case the fully optimal policy cannot be represented as a feedback rule. Simple rules also feature in studies of policy credibility, since they make policy more transparent and easy to monitor.

This is certainly a more realistic view of monetary policy which, through the setting of official interest rates, is explicitly focused on the control of inflation in several OECD countries (including the United Kingdom) or monetary aggregates otherwise. In this respect there is a growing literature assessing the statistical performance of different policy regimes through the application of appropriate analytic or numerical techniques to a macroeconomic model. An important precursor is the classic article by Taylor (1979), who estimates a two-equation model of the US economy with rational expectations, uses it to calculate optimal monetary policy rules to stabilise fluctuations in output and inflation, and hence defines and estimates a long-run trade-off between the variability of inflation and the variability of output. Much of the subsequent work has continued to use simple stylised models as the research vehicle. Recent examples based on a model comprising an aggregate demand equation and a price determination equation or 'Phillips curve' are Bean (1998) for the United Kingdom and Rudebusch and Svensson (1998) for the United States. Simple models admit analytic solution methods, whereas large-scale models require stochastic simulation methods, hence applications are less prolific. The two studies mentioned above are part of a voluminous and yet growing literature, whereas the work of Blake (1996) on the NIESR model of the UK economy and work on the US Federal Reserve Board's model summarised by Reifschneider *et al.* (1997) are more rare examples.

Monetary policy rules may include both change and level formulations. The former sets the change in the short-term nominal interest rate as a function of deviations of inflation from target and, possibly, output from potential output. The latter sets the level of the interest rate as a function of similar arguments; this includes the form known as the 'Taylor' rule, found to provide a reasonable approximation to actual policy-making (Clarida, Gali and Gertler, 1998, 2000). A further development associated with the name of Svensson (1997a) is the inclusion of terms in the deviation of forecast future inflation from target, such forward-looking rules probably being closer to central bank practice. However, despite the growing interest in the design of monetary policy rules, the prevailing view of macroeconomic equilibrium noted

above implies an important shift in the main focus of attention, namely from first moments to second moments, statistically speaking. Neither the small stylized models used in this research nor typical large-scale models admit a long-run trade-off between the *level* of output and inflation, and alternative monetary policy rules are evaluated in terms of the *variances* of outcomes, as in Taylor's original study. However, in the presence of non-linearities featuring the inflation-output nexus, monetary policy can still induce 'first-order effects', though maintaining the long-run natural rate hypothesis. By use of a small stylised model, Clark and Laxton (1997) show that any policy which is more effective in stabilising fluctuations in the business cycle, thereby reducing the *variance* of inflation, is also able to lower the *mean level* of unemployment in the economy.

Summarising, the fall of first-generation large-scale macroeconometric models as a tool for policy analysis has not led to a wholesale rejection of the model-based approach to forecasting and analysis of the economy. It is undeniable that all models are, at best, only a rough approximation to the workings of a modern economy, despite attempts to make them more theory-consistent and the use of more sophisticated econometric techniques. However, abandoning completely a formal framework would amount to render policy fully dependent on the implicit models in the mind of policy makers. These implicit models are less transparent and less likely to be consistent over time. Moreover, they lend themselves with difficulty to empirical falsification, while they are more likely to be internally inconsistent. Downgrading the role of formal models in the policy process would leave a vacuum that is unlikely to be re-filled by an entirely subjective approach. A formal and quantified approach is thus an irreplaceable adjunct to the process of policy thought. For these reasons, the abovementioned developments in macromodelling can be seen as a *sine qua non* to re-gain policy-makers' confidence in models. To fully achieve such a target, models must be constructed in a way that is consistent with sound theoretical predictions. At the same time, their outcomes must be consistent with (and able to replicate) relevant historical episodes. Further, there are many different ways in which the information contained in econometric

models can be used for deciding on appropriate policy actions and assessing the likely effects on target variables. The judgemental part of the process must, then, be explicit to provide an acceptable treatment of the inherent uncertainty.

This thesis presents a number of examples in which macroeconomic models are used for evaluation of contemporary policy problems. I employ different approaches to highlight how macromodels can actually help policy-makers to think about the economy. Using a range of models recognises the inherent uncertainty about the underlying economic structure and its sensitivity to structural changes. Moreover, small stylised models, large-scale country models and global models are likely to contribute to the policy debate only if collectively employed, as they possess complementary features which can enrich and rectify each others' conclusions. Smaller models, for instance, have the advantage to make the underlying paradigm more transparent. They can be solved as static models with calibrated parameters or in dynamic versions with econometrically estimated coefficients. Small stylised models of the UK economy are estimated in the first part of this thesis. They are used to assess the performance of simple monetary policy rules under the current monetary regime. In a monetary policy regime of inflation targeting, the objective is typically specified as a range of outcomes for future inflation. Since monetary policy affects inflation with a lag, current policy is set in relation to forecasts of future inflation; since forecasts are subject to error, point targets will almost always be missed, and an indication of the inherent uncertainty is given by a target band. The approach used in chapter 2 to the determination of an appropriate band width is to build a small stylised model of the economy and then use suitable analytical techniques to assess the variance of inflation under alternative policy reactions to shocks. An influential study recently published by the Bank of England (Haldane and Salmon, 1995) estimates a 'small semi-structural model' of the inflation process with backward-looking expectations, and uses stochastic simulation techniques to calculate the variance of inflation under simple feedback rules for interest rates. The study's most striking conclusion is that there exists 'a fairly substantial lump of inflation uncertainty' in the United Kingdom.

Specifically, their results imply that there is ‘on average, a no better than one in four probability of hitting a 1%-4% inflation target’. Chapter 2 shows that such previous findings are essentially driven by the assumptions and shortcomings embedded in the model used for their analysis. Incorporating an exchange-rate transmission channel and allowing for an explicit forward-looking treatment of expectations in both labour and foreign markets seems in fact a more sensible way of portraying agents’ reaction to monetary regime shifts (Miller and Sutherland, 1990). At the same time, it permits to take into account two important transmission mechanisms generally closed off in other studies: exchange rate and expectations channels. Other relevant features are however still missing from the small stylised model used in chapter 2, for instance an explicitly forward-looking behaviour in price and wage determination and a more complete integration of steady-state properties and short-run dynamic adjustments. These extensions are considered in chapter 3 together with a wider range of policy rules, including ‘inflation forecast targeting’ à la Svensson (1997a, 1998b) and ‘Taylor’ rules, while taking into account the impact of different degrees of forward-lookingness in both inflation targeting horizon and wage bargaining on the effectiveness of monetary policy. Linearity and analytical tractability of the empirical model are, however, retained. In this way, the extension of Blanchard and Kahn’s (1980) solution method for rational expectations models deployed in chapter 2 can be used here to calculate asymptotic variances of inflation and output. Within the model, particular relevance is given to the determination of wages and prices, reflecting the substantial developments in this area in the last decades. In this respect, careful attention is granted to both statistical and economic issues, by recognising the need to go beyond single-equation modelling and the policy implications of the empirical study.

The remainder of the thesis examines the transmission mechanism of monetary policy from different standpoints. Large-scale country models have the convenience to make explicit a complete range of relationships among macroeconomic variables most of which, for obvious reasons, are neglected in small stylised dynamic models. As a consequence, such quantitative

framework offers an unique opportunity to evaluate not only the aggregate impact of exogenous shocks on the variables of interest, but also to identify the underlying economic mechanisms enabling the transmission of such shocks. In the second part of the thesis, I use simulation of the National Institute's Domestic Econometric Model (NIDEM) to analyse the characteristics of the UK monetary transmission mechanism. In view of the UK's decision not to enter the Economic and Monetary Union (EMU) at its commencement, there is an interest in assessing whether monetary policy would exert an analogous influence on the real economy under the current monetary arrangements and a fixed exchange rate. Furthermore, the chapter attempts to fill the gap between the traditional perspective, according to which monetary policy exerts its effects on spending components through its direct influence on the cost of capital (Taylor, 1995), and the more recent 'credit view', which argues that other 'accelerator' variables, such as cash flow, have the greatest impact on spending (Bernanke and Gertler, 1995). To do this, I focus on consumers' expenditure, and in the light of the recent literature on life-cycle consumption, I re-estimate the corresponding equation in NIDEM. The inclusion of permanent human capital, as well as the explicit modelling of Ricardian non-neutralities, is likely to account for a weaker interest rate sensitivity of consumption and a higher sensitivity of consumption to changes in current disposable income and fiscal policy. In this respect, it is of relevance disentangling the total change in consumers' expenditure and real output into the individual contributions from several transmission channels. In particular, it appears crucial to assess the repercussion effects of monetary impulses on spending components through their impact on fiscal variables. Given the decentralisation of fiscal policy and fiscal structures within EMU, evidence of a quantitatively important fiscal channel of monetary policy would weaken the argument for a symmetric response to a common change in the policy rate.

Certainly, the steady integration of the members of the EMU and increasing awareness of the need for closer co-operation in monetary and fiscal policy have stimulated greater interest in modelling interdependencies between European countries and the impact and feedbacks from the rest of the world economy. Many of the key issues have now an international aspect, so it

becomes more and more difficult to rely on single-country models to provide necessary analysis. International transmission mechanisms can therefore be better tackled with a multi-country model. The third and last part of this thesis concentrates on cross-country asymmetric transmissions in response to a common monetary shock within EMU. This is done through simulations of a neo-classical multi-country model: the IMF's MULTIMOD Mark III (MM3). In particular, chapter 5 presents an empirical analysis of the links between monetary and fiscal policy within EMU. In MM3 monetary policy has a quasi-fiscal dimension, since money both enters the government budget constraint and affects real wealth. Each European economy is characterised - even in steady state - by a different debt/money composition of deficit financing and assumed to sustain it by running a different primary surplus. This allows to assess cross-country effects of a common monetary policy in a non-Ricardian world, given heterogeneous national economies' budgetary positions. Moreover, the chapter tries to evaluate the implications of enforcing an institutional arrangement such as the Stability and Growth Pact in equilibrium and during transition to the new steady state. Finally, the role of different degrees of efficiency in European credit markets in driving asymmetric responses is also assessed.

The other important source of asymmetric monetary transmission can certainly be identified in the presence of different degrees of nominal and real rigidity in national labour markets. Such heterogeneity in the underlying structure of the economies is liable to determine the size and speed of country-specific adjustments to a common monetary shock. By use of the same model-based quantitative framework, chapter 6 examines the role of nominal and real rigidities in European labour markets for an assessment of alternative monetary regimes. Meanwhile, it tries to answer a number of relevant questions. Is the choice of which institutional monetary arrangement neutral with respect to cross-country real divergences? Do different extant economic conditions represent weighty barriers to the process towards convergence? Can labour market flexibility correct for asymmetric policy responses thereby favouring convergence across European countries? Is labour market flexibility always good

news? The choice of MULTIMOD Mark III as tool of analysis is here driven by its inherent assumption of asymmetry in the transmission mechanism between unemployment and inflation. In fact, MM3 embeds a non-linear Phillips curve, thought under the hypothesis of existence of a natural rate of unemployment. In the presence of convexity of the inflation-output trade-off, it is possible to show that monetary policy choices have real effects in the long run. Moreover, in an EMU context, the presumption of a convex Phillips curve implies that country-specific adjustments to a common monetary shock depend crucially on the relative initial position of the economy, and not only on the parameter estimates of its short-run inflation-output trade-off.

Part One

Small Stylised Models

Chapter Two

Inflation Target Bands and the 'Fairly Substantial Lump of Inflation Uncertainty' in the UK

2.1 INTRODUCTION

During the 1990's, New Zealand, Canada, UK, Sweden and Australia have shifted to a new monetary policy regime, inflation targeting¹.

Main feature of this monetary regime is the existence of an explicit quantitative objective for future inflation. The explicit inflation target is either in the form of an interval or a point target, where the center of the interval or the point target currently varies across countries between 1.5 in New Zealand (since 1997 the target range is of 0-3 percent, whereas during the period 1990-1996 the target range was 0-2 percent), 2 percent in Canada and Sweden,

¹ Finland and Spain also announced inflation targets while still being members of the ERM. Israel has announced inflation targets while still maintaining an exchange rate band. Recently, Chile and the Czech Republic also joined the group of inflation-targeting countries. Indeed, Cecchetti and Ehrmann (1999) claim the number of

and 2.5 percent in Australia and United Kingdom. The target refers to the CPI or a variant of this that excludes some transitory components. For instance, taxes and subsidies may be excluded (to eliminate short-run effects of fiscal policy) or mortgage costs and credit services, as in the case of the UK which targets RPIX (to eliminate contradictory short-run effects of monetary policy on the CPI). Alternatively, as it is the case for New Zealand which focuses on 'core inflation', a list of factors to be disregarded in the evaluation of monetary policy may be specified in advance.

This profound shift in policy making has been accompanied by an equally impressive attention to monetary policy institutional arrangements, in both theoretical and empirical economic research (for recent reviews, see Eijffinger and de Haan, 1995; Obstfeld and Rogoff, 1996; Walsh, 1998). The most important finding in this context is that delegation of monetary policy to an independent central bank can eliminate the inflation bias of monetary policy. The inflation bias arises in equilibrium because the ex-ante optimal policy plan is not time-consistent: as private agents are aware of policy-maker's incentive to renege on his announced policy ex-post, their choices will embody government's expected reaction, thereby making resulting policy suboptimal (Barro and Gordon, 1983). Rogoff (1985) was the first one to suggest that delegation to an independent conservative central bank reduces inflation bias, though increasing volatilities. Rogoff's suggestion seems then to carry out a trade-off between credibility and flexibility. Walsh (1995) points out that the inflation bias can be eliminated without distorting stabilisation policy through a performance contract, which penalises central banker's remuneration in a linear fashion with respect to deviations of realised inflation from target. Svensson (1997a) shows that Walsh's optimal incentive structure can also be achieved through an inflation targeting which grants independence to central bank in the conduct of monetary policy but lets government choose the target. McCallum (1995) notes that this arrangement does not prevent revisions of the inflation target after private decisions has been made. However, as shown in Herrendorf (1998), a

countries' central banks with either an explicit monitoring range or an actual target for inflation to have risen to

legislated delegation arrangement can restrict the discretionary influence of government and make monetary policy more transparent. This allows the private sector to monitor closely the actions of the government and disciplines the government not to behave in a time-inconsistent way. In the end, inflation targeting reduces equilibrium inflation because it makes reputation more effective.

Inflation targeting is not, however, the only mechanism which has been recognised by the literature as reputation-enhancing. International institutional arrangements like the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS) have also been understood as reducing the inflationary bias. The usual argument in their favour was that they provide additional credibility to monetary authorities of inflation-prone countries (Giavazzi and Giovannini, 1986; Giavazzi and Pagano, 1988). This credibility hypothesis sees the ERM as enabling member countries to 'borrow' reputation from the Bundesbank by credibly pegging their exchange rates to the Deutsche Mark. This commitment technology, however, collapsed under the burden of German reunification. This is due to the asymmetrically functioning system which is inherent to the exchange rate targeting: whereas the anchoring country chooses independently its monetary-fiscal policy mix, pegging countries are forced to 'borrow' the consequences of such a policy mix, regardless its suitability with respect to domestic targets. Theoretically, money-growth targeting can also provide an internal anchor thereby helping in reducing inflation bias. If credible, a money-growth rule as in Friedman (1968) would remove the room for discretionary monetary policy. This approach assumes, however, that the policy-maker has perfect control over his chosen policy intermediate target (via the policy instrument, i.e. the repo rate) and that this maintains a stable relation with prices, being price stability the final target of the policy. Both assumptions are tenuous. Central banks have great difficulties in attaining even their announced money target and the relation between the development of the money stock, variously defined, and prices, is notoriously fickle (Blinder, 1998; Svensson, 1999). Money-

growth targeting is thus likely to be credibility-damaging rather than credibility-enhancing, as it proposes a prominent role for an essentially irrelevant indicator in both analysis and communication, whereas it keeps secret the decisive input for the conduct of monetary policy, i.e. inflation forecasts.

Inflation targeting has certainly some practical advantages with respect to its more direct counterparts, i.e. exchange rate, money-growth or nominal GDP-growth targeting², as repeatedly shown by Svensson (1997a, 1997b, 1998a, 1998b, 1999). The general advantage involves focusing monetary policy directly on achieving the goal of low and stable inflation. With a specified target, it provides an ex-post measurement of monetary policy performance, namely deviations of realised inflation from target. It also provides measurement of monetary policy credibility, in the form of discrepancies of inflation expectations from target. Both these measurements simplify evaluation of monetary policy, thereby increasing its transparency and accountability. By increasing accountability, inflation targeting may, in turn, serve as a potential commitment mechanism, reduce or eliminate any inflation bias and increase the likelihood of achieving and maintaining low and stable inflation, as well as anchoring and stabilising inflation expectations.

Under this monetary arrangement, inflation-targeting central banks are in fact asked to issue regular reports explaining and motivating their policy to the general public. In New Zealand, for instance, the Reserve Bank Governor's performance will be evaluated by the Reserve Board of Directors and his job is potentially at risk if realised inflation is believed to have moved outside the band because the Governor chose an ex-ante inappropriate policy. In the UK, the Chancellor of Exchequer has announced the 'Open Letter System': if inflation deviates more than 1 percentage point from the 2.5 percent inflation target, the Governor of

² Rudebusch (2000) discusses the role of nominal income as a possible target variable for monetary policy. He suggests that nominal income target rules perform poorly under model and data uncertainty. Explanation is found to be related to the evidence that inflation and real output respond to monetary policy changes with different lags. Instead, by construction, a nominal income target constrains monetary policy to react identically to fluctuations in each of its components. Further, Svensson (1997) and Ball (1999) show that in backward-looking models nominal income targeting may lead to dynamic instability. However, McCallum (1997) argues that this is not the case in models embedding rational expectations of inflation.

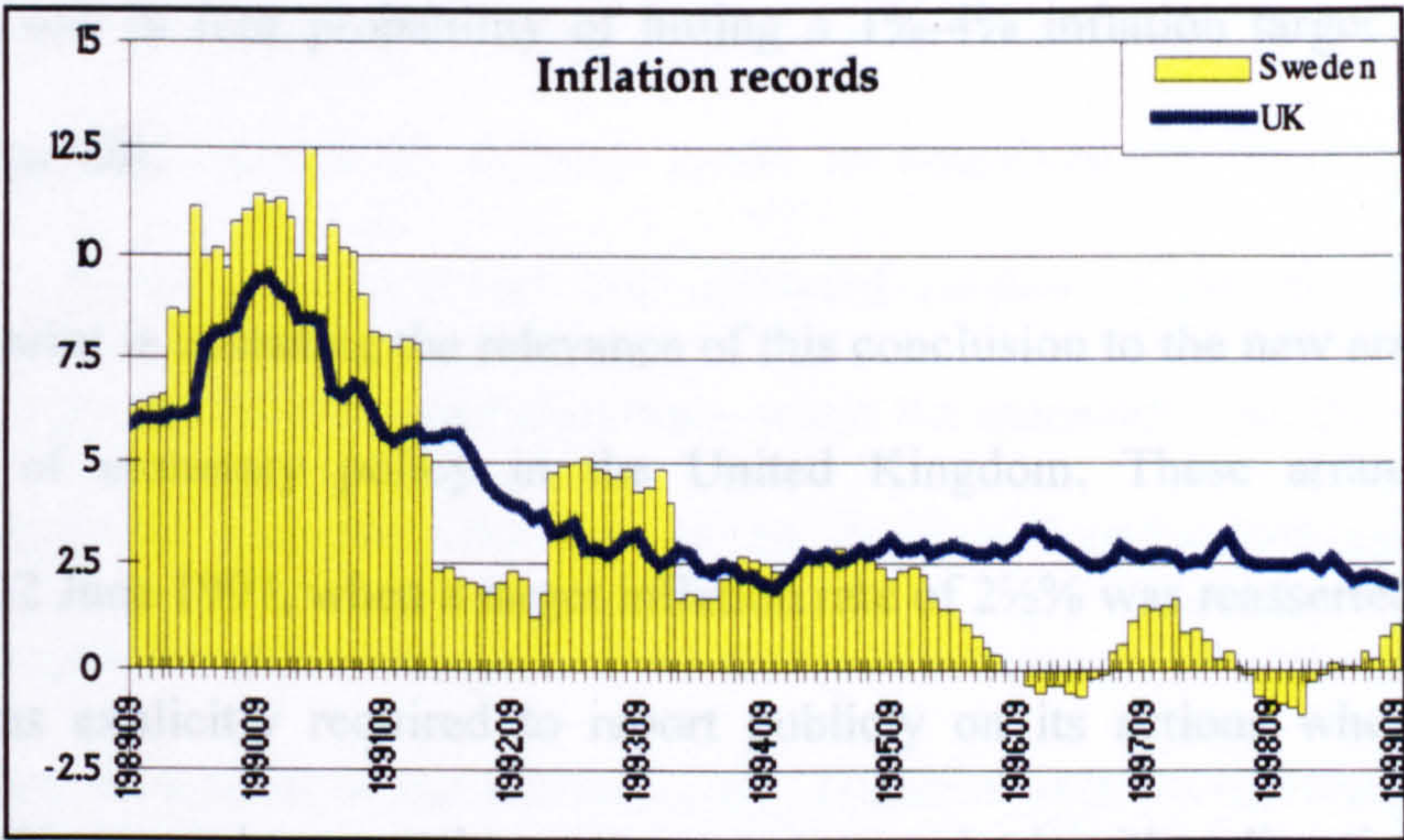
the Bank of England shall explain in an open letter why the divergence has occurred and what steps the Bank is taking to deal with it. The inflation-targeting central banks explain and motivate their policy in regular Inflation Reports. Three of them (Reserve Bank of New Zealand, Bank of England and Sveriges Riksbank) publish graphs of conditional inflation forecasts, such that outside observers can check whether the targeting rule is fulfilled. The Bank of England, in particular, since its first Report in February 1993, plots conditional inflation forecasts for a constant unchanged interest rate. Since November 1997, it also plots corresponding forecasts for output. Moreover, the Bank of England publishes the minutes of the meeting of its MPC within 6 weeks of each meeting, including voting records³. This assigns individual responsibility to MPC members and certainly makes monitoring of monetary policy much easier than under any other monetary arrangement.

In this respect, it could be useful to recall that the introduction of inflation targeting in countries like UK and Sweden occurred in autumn 1992 under rather dramatic circumstances⁴. The countries went through dramatic boom-bust experiences, serious banking and financial-sector crises and a sudden shift from a fixed exchange rate like the ERM to a new monetary policy regime with a floating exchange rate. Furthermore, this occurred in a situation with very low credibility for monetary policy, with high and unstable inflation expectations, much above the announced inflation targets. Despite that, inflation-targeting countries have registered a remarkable track for inflation since the introduction of the new monetary arrangements, as shown in Figure 2.1 for the case of the UK and Sweden and extensively documented in Cecchetti and Ehrmann (1999). This certainly supports the thesis which sees inflation targeting as an effective commitment technology which enhances reputation while inducing time-consistent behaviour on the part of the policy-maker.

³ A problem with publishing MPC minutes is that the discussion could be inhibited and that crucial discussion might be moved outside that context. However, the minutes do not state what was said by whom and only presents summaries of the arguments, which should mitigate the first problem. The moral integrity of MPC members should work as a guarantee for the rest.

⁴ The UK abandoned the ERM on 23 September 1992, a day that is usually referred to as 'black Wednesday'. Similarly, Sweden left the ERM on November 1992 and announced the new inflation targeting regime on January 1993.

Figure 2.1: Annual inflation for Sweden and the UK (percentage points)



Based on monthly RPIX data over the period 09/89-09/99

As noticed above, in a monetary policy regime of inflation targeting the objective is typically specified as a range of outcomes for future inflation. Since monetary policy affects inflation with a lag, current policy is set in relation to forecasts of future inflation; since forecasts are subject to error, point targets will almost always be missed, and an indication of the inherent uncertainty is given by a target band. It may be expressed as a point target plus or minus a certain tolerance, or directly as a target range. How wide should the band be? Credibility considerations work in both directions, as Goodhart and Viñals (1994, p.148) observe: ‘the selection of band width involves a trade-off between the credibility-enhancing effects of choosing a quite demanding target and the credibility-damaging effects of failing to adhere to it’. The question of the number and nature of escape clauses and exemptions that are allowed in some inflation targeting countries is also related to the band-width question.

An influential study for the United Kingdom recently published by the Bank of England (Haldane and Salmon, 1995) estimates a ‘small semi-structural model’ of the inflation process with backward-looking expectations and uses stochastic simulation techniques to estimate the variance of inflation under simple feedback rules for interest rates. The study’s

most striking conclusion is that there exists 'a fairly substantial lump of inflation uncertainty' in the United Kingdom, quoting a phrase which is used three times in the original article and once more by Haldane (1995). Their results imply, for example, that there is 'on average, a no better than one in four probability of hitting a 1%-4% inflation target' (Haldane and Salmon, 1995, p.180).

Several issues arise in assessing the relevance of this conclusion to the new arrangements for the operation of monetary policy in the United Kingdom. These arrangements were completed on 12 June 1997, when a target inflation rate of 2½% was reasserted and the Bank of England was explicitly required to report publicly on its actions whenever inflation deviates from this target by more than one percentage point in either direction. On Haldane and Salmon's estimates, such a report will be required rather frequently, although the probability distribution surrounding the conditional projections of inflation in the Bank's quarterly *Inflation Report* suggests that this will be a less frequent requirement. This conclusion rests on estimates of the standard deviation of annual inflation which range from 3 to 4½ percentage points depending on the feedback rule and assumptions about the residual covariance matrix. It is immediately apparent, however, that the model used by Haldane and Salmon has several shortcomings. First, from a statistical point of view, the wage and price equations are estimated in first-difference form, reminiscent of an earlier Bank study, of the demand for money (Hacche, 1974), which motivated the exposition by Hendry and Mizon (1978) of Sargan's 'common factor' analysis. Second, from an economic point of view, the (real) exchange rate is treated as exogenous, thus an important channel of interest rate transmission is closed off. Overall, various statistical and economic features of its specification result in a model that lacks the neutrality properties of the standard Dornbusch model whereby, for example, an exogenous reduction in the inflation target produces the same reduction in actual inflation, with a long-run reduction in the nominal interest rate again of the same amount, leaving the real rate of interest unchanged.

The chapter proceeds as follows. In Section 2.2 the Haldane-Salmon model and the stochastic simulation exercises based upon it are reviewed, indicating that several of their results can be anticipated once it is recognized that inflation responds only weakly to interest rate changes in this model. The model is essentially linear, and instead of stochastic simulation techniques, analytical methods could be employed. In Section 2.3 these are developed and applied to our revised and extended version of the model. Some small revisions are made to their estimated equations, while the extensions are the endogenization of the exchange rate and the adoption of an explicit forward-looking treatment of expectations. In general these changes reflect the specification of relevant parts of leading large-scale structural models of the UK economy. Together with a recalibration of the error covariance matrix to reflect the reduced magnitude of shocks experienced in the last decade of the sample, these changes achieve a fairly substantial reduction in inflation uncertainty. In our estimates the probability of hitting a 1%-4% inflation target is increased from 'no better than one in four' to 0.87. Section 2.4 contains concluding comments.

2.2 THE HALDANE-SALMON MODEL

The model used by Haldane and Salmon (henceforth HS) is a modified IS/LM system. The simplified representation in equations (2.1)-(2.5) below reports the variables that appear on the two sides of each estimated linear equation.

$$\text{IS curve: } \Delta y: \Delta y_{-1}, \Delta(m - \hat{p}), \Delta(m - p)_{-1}, \Delta g, \Delta q_{-1}, \Delta q_{-2}, \Delta y^* \quad (2.1)$$

$$\text{LM curve: } \Delta(m - \hat{p}): \Delta(m - p)_{-1,-2}, \Delta \hat{p}, i, (m - p - 0.79y + 0.30\sum i)_{-1} \quad (2.2)$$

$$\text{Cost mark-up pricing: } \Delta p: \Delta p_{-1,-2}, \Delta w, \Delta w_{-1}, \Delta w_{-2}, \Delta pim_{-1}, \Delta pim_{-2}, \Delta pim_{-3} \quad (2.3)$$

$$\text{Wage bargaining: } \Delta(w - \hat{p}) : \Delta w_{-1,-2,-3,-4}, (y - \bar{y}), (y - \bar{y})_{-1} \quad (2.4)$$

$$\text{Price-expectation formation: } \Delta p : \Delta p_{-1,-2}, \Delta m_{-1} \quad (2.5)$$

All variables except the nominal short-term interest rate (i) are in logarithms, Δ is the first-difference operator, and lags (in quarters) are indicated by subscripts, autoregressive terms being collected together and listed first.

The IS curve, equation (2.1), relates real output (y) to real money balances ($m-p$), real government expenditure (g), the real exchange rate (q) and real overseas output (y^*). It is unconventional in using real money balances rather than the real interest rate. The argument is that interest rate policy operates indirectly, first depressing real money holdings via the LM curve, rather than directly via the IS curve. As noted above, the real exchange rate is treated as exogenous, as are government expenditure and foreign output. Equation (2.2) is an LM curve which follows Breedon and Fisher (1993) by including an error correction term in which a cumulative interest rate variable (Σi) is used to capture the upward trend in velocity. Agents are assumed to make decisions over nominal money holdings (and nominal wages, see below) without full information about current inflation, hence *expected* inflation appears in this equation, also in the contemporaneous real money variable in the IS equation.

Equations (2.3) and (2.4) comprise the wage-price system, described as a 'reduced-form and simplified version' of a Layard-Nickell (1985) bargaining model. Prices, measured as the GDP deflator, are a constant mark-up on nominal wages (w) and exogenous import prices (pim). Nominal wage bargaining is based on expected inflation, as noted above, and is subject to nominal inertia and the pressure of demand as measured by the deviation of output from trend ($y - \bar{y}$), the residuals in a regression of y on a linear trend. Finally, equation (2.5) describes the formation of price expectations, the fitted values from this equation providing the 'data' on expected inflation in equations (2.1), (2.2), and (2.4). These expectations are clearly not rational, as HS note: rather than a complete reduced-form

equation of the four-equation system, equation (2.5) contains only three of the predetermined variables of the model.

Two econometric issues are immediately apparent. First, this expected inflation variable is a generated regressor in the sense of Pagan (1984), and while this presumably explains why HS estimate equation (2.2) by the instrumental variables (IV) method, it should be noted that this is not done in equation (2.1). Second, the method of ordinary least squares (OLS) is used to estimate the remaining three 'semi-structural' equations (2.1), (2.3) and (2.4) despite the fact that they each include a current endogenous variable on the right-hand side.

To answer the inflation target band-width question HS next augment the model with a monetary policy feedback rule and calculate the variance of inflation in various scenarios. Before reviewing these exercises, the suitability of the model for this purpose is assessed, in particular asking whether some of their results can already be predicted.

The estimated wage-price system does not exhibit dynamic homogeneity, hence this model does not have the natural rate property. Of greater importance for the present purpose, however, is the strength of the output gap effect on inflation, since this is the final link in the transmission of interest rate changes via the IS curve. In the steady-state solution of the HS estimates of these two equations, assuming consistent expectations, the coefficient of the output gap in the price inflation equation is 0.12. This has the interpretation that holding output 5% below trend, which is the maximum deviation seen in the sample, occurring during the 1979-81 recession, reduces the annual inflation rate by only 2.4 percentage points. Taking equation (2.5) into account makes this response yet smaller, since expectations are estimated to reflect less than the full extent of observed inflation, although this equation also adds a direct expectational channel for monetary policy. The impact of interest rates on output implied by the HS estimates of the IS/LM system is less easy to summarise, given the dynamic forms of these equations, although the effects do not appear to be large. The overall

impression of a very weak link between interest rates and inflation is confirmed in subsequent results, discussed below.

Inflation targeting is studied by augmenting the model with an interest rate feedback rule, and HS consider the following two variants

$$\Delta i_t = \lambda (\Delta p_{t-1} - \Delta p^T) \quad (2.6)$$

$$\Delta i_t = \lambda [E_{t-1}(\Delta p_{t+1}) - \Delta p^T] \quad (2.7)$$

where Δp^T is the inflation target, set at 2½% per annum in their practical exercises. Equation (2.6) is a conventional backward-looking rule, adjusting interest rates in line with observed deviations of inflation from its target, whereas equation (2.7) is described as a forward-looking rule and responds to deviations of next period's expected inflation from the target. As HS note, this kind of rule is probably closer to central bank practice, and such 'inflation forecast targeting' rules have subsequently been extensively analysed by Svensson (1997a, 1997b). In implementation, however, HS again eschew rational expectations and instead apply the backward-looking equation (2.5), except that in calculating the expectation of Δp_{t+1} otherwise based on information dated $t-1$, the central bank is assumed to know Δm_t , and so is given an information advantage.

The performance of the rules is assessed by stochastic simulation. The six-equation system is subjected to repeated pseudo-random shocks with variances equal to the residual variances of the estimated equations, and the variability of the resulting outcomes for inflation is reported. A band of one standard deviation on either side of the mean outcome has width ranging between 6 and 9 percentage points depending on the rule and on assumptions about the residual variances and covariances, leading to the conclusion quoted above that there exists 'a fairly substantial lump of inflation uncertainty'. No information is given about the residual variance of inflation, however, and we are not able to reproduce the HS estimates

from their data to calculate this ourselves, so the extent to which the feedback rules are an improvement over historical experience cannot be assessed. We note, however, that the results are relatively insensitive to the change in the feedback parameter that is reported, namely from $\lambda = 0.25$ to $\lambda = 0.5$. Further, when HS report outcomes under various extensions of the rules for a wider range of λ -values, the results are again relatively insensitive to variations in λ . (No information about the simulation standard errors of their estimates is provided, hence the significance or otherwise of the reported differences cannot be assessed.) In general the insensitivity of inflation variability to the strength of the feedback onto interest rates would be expected in a backward-looking model in which the responsiveness of inflation to changes in interest rates was small, since the overall reduction in inflation variance depends on the convolution of these two effects.

A simple check of the properties of the HS model under feedback control is provided by a (deterministic) simulation of the effect of a reduction of 1% per annum in the inflation target, as used for comparative purposes by Church *et al.* (1996, 1997). They find that in the NIESR model of the UK economy, for example, this produces the same reduction in actual inflation, with a long-run reduction in the nominal interest rate also of the same amount, leaving the real rate of interest unchanged, as in a standard Dornbusch model. Of course the NIESR model, like other UK macro models, treats the exchange rate as an endogenous variable, whereas this channel is ignored in the HS model. Here the equivalent simulation produces nonsensical results, with interest rates rising by more than 50 percentage points.

In the next section we consider a revision of the HS model which incorporates an endogenous exchange rate and remedies other deficiencies noted above. This is then used to calculate the variance of inflation in a targeting regime. From a technical point of view we note that the HS model is essentially linear, hence such quantities can be calculated by analytic methods, and the use of stochastic simulation techniques is not necessary.

2.3 A REVISED AND EXTENDED MODEL

We remain within the 'small stylised model' framework, and make the minimum necessary changes to the HS model, restricting ourselves to the same data set. As noted above, however, we are not able to reproduce the HS estimates, so the option of leaving some equations exactly as in their article is not available to us. Endogenising the exchange rate introduces an additional expectations variable, and such variables are treated as model-consistent or rational expectations throughout.

The first four equations have the same role as in the original HS model, and are represented in the same summary form in equations (2.8)-(2.11) below. Each equation also contains one or two dummy variables to deal with outliers; full estimation results are presented in the appendix A of this chapter.

$$\Delta y : \Delta(m-p), \Delta g, \Delta q_{-1}, \Delta y^* \quad (2.8)$$

$$\Delta(m-p) : \Delta(m-p)_{-1,-2}, i_{-1}, (m-p-y)_{-1}, trend \quad (2.9)$$

$$\Delta p : \Delta p_{-1,-2,-4}, \Delta w_{-1}, \Delta w_{-2}, \Delta pim_{-1}, \Delta pim_{-2}, \Delta pim_{-3}, \Delta pim_{-4}, (y - \bar{y}) \quad (2.10)$$

$$\Delta w : \Delta w_{-2}, \Delta p, \Delta p_{-1}, (y - \bar{y}) \quad (2.11)$$

Equation (2.8) is estimated by IV, and some insignificant lagged variables have been deleted. Equation (2.9) now follows more closely the specification of the corresponding equation in the Treasury model of the UK economy (Chan *et al.*, 1995), in particular preferring a linear trend to the cumulated interest rate proxy for financial innovation. The revised price equation, (2.10), imposes dynamic homogeneity, which is a common property in UK macro-models, although they typically use a unit labour cost variable in place of nominal wages. The price mark-up also varies with the pressure of demand, again as in the Treasury model,

although here too a different measure is used. Finally the wage equation, (2.11), now also has dynamic homogeneity imposed.

The exchange rate transmission channel is represented in this framework by including two additional equations, as follows:

$$e_t = \hat{e}_{t+1} + (i_t - i_t^*) \quad (2.12)$$

$$\Delta pim: \Delta pim_{-1,-2}, \Delta p, \Delta(p^* - e). \quad (2.13)$$

Equation (2.12) is the uncovered interest parity or open arbitrage condition, written in nominal terms, with i_t^* denoting the foreign interest rate. This is a standard specification in models of the UK economy and of the global economy. We do not estimate this equation but simply note that the implied restrictions typically cannot be rejected in estimation, as in Chan *et al.* (1995), for example. An implication of (2.12) is that the real exchange rate in the IS curve now becomes an endogenous variable, but the main effect on inflation comes through import prices, as described in equation (2.13). The real exchange rate in the HS data set is the nominal US/UK exchange rate adjusted by the ratio of foreign to domestic prices, and we use the same foreign price variable, p^* , for simplicity, despite its mismatch in coverage with the import price deflator, pim . The specification of the equation follows the general pattern of the Treasury model, where trade prices are determined by world prices/costs in sterling and domestic prices. The equation is dynamically homogeneous, ensuring the dynamic homogeneity of the complete wage-price system. Together with the UIP condition this produces the result that, in steady state, any change in inflation in response to a shock is matched by an equivalent change in the nominal interest rate, leaving the real interest rate unchanged, as in the simulation experiments by Church *et al.* (1996, 1997) described above.

We consider an inflation-forecast-targeting policy rule as in equation (2.7), repeated and simplified for convenience as follows:

$$\Delta i_t = \lambda (\Delta \hat{p}_{t+1} - \Delta p^T). \quad (2.14)$$

The resulting model, equations (2.8)-(2.14), contains rational expectations of two future-dated variables. It is linear in the variables of concern, once the first difference of the logarithm of the price level is equated to the inflation rate, for example, and so can be analyzed using the solution methods of Blanchard and Kahn (1980). For values of λ sufficiently greater than zero the number of eigenvalues outside the unit circle (two) is equal to the number of 'non-predetermined' variables of the model, hence it is saddlepath stable. It can be expressed entirely in real terms, and so is consistent with a unique real equilibrium.

Calculation of forecast variances rests on an extension of the Blanchard-Kahn method, as described in appendix B of the present chapter, which gives an expression for the steady-state variance (see also Blake, 1996). As explained in the appendix, our calculations do not require the use of stochastic simulation techniques⁵. Results for forecast standard errors of inflation at various horizons, under inflation forecast targeting as in (2.14), are shown in Table 2.1. The upper panel is based on a covariance matrix of the underlying random shocks estimated as the residual covariance matrix over the complete HS sample period (1959q2-1993q4). It is clear from the estimation results in the Appendix, however, that the residuals of the price equation are heteroscedastic. The variability of inflation falls as the level of inflation falls, as suggested by Friedman (1977) and subsequently verified empirically in many different contexts, and also true here. Of greater relevance at the present time is then the lower panel of Table 2.1, based on the covariance matrix of the last ten years' residuals (1984q1-1993q4) and so excluding major inflationary episodes in the earlier part of the sample.

⁵ The software package that was used to carry out algebraic calculations was Matlab.

Table 2.1 Forecast standard errors of inflation (percentage points per annum)

Years ahead	$\lambda = 0.35$	$\lambda = 0.5$
<i>Full-sample covariance matrix</i>		
1	2.38	2.26
2	2.69	2.65
5	3.09	3.09
<i>Sub-sample covariance matrix</i>		
1	0.93	0.86
2	1.03	0.98
5	1.14	1.12

The most striking feature of the table, although this is not our main focus of attention, is the comparison between the two panels: the reduction in the variance of shocks to their more recent level more than halves the standard error of inflation. Secondly, the standard error of inflation increases as the forecast horizon increases, although more slowly than in conventional backward-looking models: implicitly the variance of forward expectations has an effect on that of current expectations that is anticipated. Thirdly, the variability of inflation is not very sensitive to the feedback parameter, λ . Of course the actual trajectories of interest rates and inflation in response to shocks, particularly in respect of the initial jump and subsequent short-run adjustment, do vary as λ varies, but the variance of such trajectories around their mean is less different.

Comparing our results with the original HS results, we see that incorporating the exchange-rate transmission channel and an explicit forward-looking treatment of expectations reduces the estimated standard deviation of inflation to approximately 50 per cent of their figures. Calibrating the variances and covariances of random disturbances to the experience of only the last decade of their sample achieves a further reduction of a little more than one-half.

Overall, in our modified version of this 'small semi-structural model' the standard error of inflation four to eight quarters ahead is less than one percentage point. If we focus on the two-year horizon, given the Bank's view that it takes two years for monetary policy to have its maximum effect on inflation, and use a normal approximation, then the results imply that, in place of the HS estimate of 'on average, a no better than one in four probability of hitting a 1%-4% inflation target', our estimate of this probability is 0.87. The lump of inflation uncertainty is thus substantially reduced.

2.4 CONCLUSIONS

In contrast to Haldane and Salmon's argument for an inflation target band width 'at least as large as the three percentage points currently [1995] operating in the United Kingdom - and possibly much wider', we find that some simple extensions to their analysis yield the argument that a tolerance interval of plus or minus one percentage point can be achieved approximately two-thirds of the time. (This interval corresponds to the Chancellor's Mansion House statement if we ignore the difference between the GDP deflator, used in the above analysis, and the Retail Price Index excluding mortgage interest payments, which is his preferred target variable.) An important contribution to this improvement comes from the recognition that the underlying variance or uncertainty of inflation has fallen as the level of inflation has fallen, and further reductions may already be appropriate as central bank credibility has increased, the sample period used by Haldane and Salmon (and ourselves) ending in 1993. Also contributing are our extensions to their model, endogenizing the exchange rate and treating expectations in an explicit forward-looking manner. These extensions are kept to a minimum, since our present purpose is to confront the 'substantial lump of inflation uncertainty' on its home ground of a small stylised model of the inflation process; this also allows us to deploy recently-developed analytic techniques for linear rational expectations models. Nevertheless these two extensions are commonplace in leading structural models of the UK economy, which also provide a more fully elaborated account of the various direct domestic channels of interest rate transmission. Other relevant features found in larger structural models but missing from the small stylised model are explicit forward-looking behaviour in price and wage determination, a consistent treatment of foreign prices and quantities, the interaction of fiscal and monetary policy, and a more complete integration of steady-state properties and short-run dynamic adjustment, typically through the use of error-correction models. Extending the analysis to a more fully specified

empirical model and a wider variety of policy rules is the aim of the next chapter. In that context, together with a wider range of policy rules, including 'inflation forecast targeting' à la Svensson (1997a, 1998b) and 'Taylor' rules, we will take into account the impact of different degrees of forward-lookingness in both inflation targeting horizon and wage bargaining on the effectiveness of monetary policy.

Comparison of our estimate of inflation uncertainty with that implicit in the probability distribution published in the Bank of England's *Inflation Report* is complicated by the fact that the latter relates to a projection of (RPIX) inflation conditional on unchanged interest rates, and precise information on the Bank's view of the interactions between these variables is not available. In addition one faces the practical difficulty of reading quantitative information off a chart measuring 2cm x 3cm; nevertheless an approximate 90% conditional prediction interval for RPIX inflation two years ahead in the August 1997 *Inflation Report* is 1%-5%. This is distributed asymmetrically around a central projection of 2.5%, and is comparable with our estimate, despite the above caveats, although its upper limit increases substantially between one and two years ahead, whereas its lower limit stays approximately constant, which is more in line with our estimates.

APPENDIX A: The estimates⁶

⁶ The failure of any test at the 5% and 1% significance level is denoted by one and two asterisks, respectively.

T-ratios are reported alongside the coefficient estimates, as indicated. In some cases, because of restrictions imposed on the parameters, the t-ratios are not available (denoted as ‘n.a.’).

Serial Correlation: A Lagrange multiplier test for up to 5-th order serial correlation.

Heteroscedasticity: Based on the regression of squared residuals on squared fitted values.

Normality: Jarque-Bera test for normality of the residuals, testing skewness and kurtosis of residuals.

Functional Form: Ramsey’s test using squares and cross products of fitted values.

Table 2.2: IS equation

- Dependent variable, Δy
- Period of estimation, 1959q2 - 1993q4
- Estimated by IV: Instrument used: fitted values of LM equation $(\Delta m - \Delta p)^{fit}$

Variable	Coefficient	t-ratio
Constant	0.0017	1.233
$(\Delta m - \Delta p)_t$	0.0877	1.846
Δg_t	0.0077	0.127
Δq_{t-1}	-0.0293	-1.802
Δy^*_t	0.5425	4.125
D74q2	-0.0313	-4.667

$\overline{R}^2 = 0.313$

$SEE = 0.0090$

Serial Correlation: $\chi^2(5) = 6.59$ [0.253]

Heteroscedasticity: $F(10,122) = 2.30$ [0.017]*

Normality: $\chi^2(2) = 7.77$ [0.021]*

Functional Form: $F(16,116) = 1.57$ [0.09]

Table 2.3: LM equation

- Dependent variable, $(\Delta m - \Delta p)$
- Period of estimation, 1959q2 - 1993q4
- Estimated by OLS

Variable	Coefficient	t-ratio
Constant	-0.027	-2.543
$(\Delta m - \Delta p)_{t-1}$	0.0665	1.108
$(\Delta m - \Delta p)_{t-2}$	0.1439	2.703
i_{t-1}	-0.8611	-5.024
$(m - p - y)_{t-1}$	-0.0817	-3.328
Trend	-0.0007	-2.892
D59q4	-0.1170	-12.58

$\overline{R}^2 = 0.656$

$SEE = 0.0116$

Serial Correlation: $\chi^2(5) = 5.33$ [0.377]

Heteroscedasticity: $F(12,119) = 1.68$ [0.088]

Normality: $\chi^2(2) = 3.18$ [0.204]

Functional Form: $F(22,109) = 1.57$ [0.068]

- Long-run solution:

$m - p = y - 10.54 i - 0.0086 \text{ Trend}$

Table 2.4: Cost mark-up pricing equation

- Dependent variable: Δp
- Period of estimation: 1959q2 - 1993q4
- Estimated by OLS

Variable	Coefficient	t-ratio
Δp_{t-1}	-0.1645	-1.936
Δp_{t-2}	0.1433	1.779
Δp_{t-4}	0.1090	1.632
Δw_{t-1}	0.2490	4.031
Δw_{t-2}	0.3114	4.722
Δpim_{t-1}	0.1362	n.a.
Δpim_{t-2}	0.0572	1.936
Δpim_{t-3}	0.0807	2.798
Δpim_{t-4}	0.0777	2.571
$(y - \bar{y})_t$	0.0485	2.282
D73q2	-0.0375	-4.319
D79q3	0.0077	1.539

$\bar{R}^2 = 0.693$

$SEE = 0.0083$

Serial Correlation: $\chi^2(5) = 5.88$ [0.318]

Heteroscedasticity: $F(23,103) = 2.30$ [0.003]**

Normality: $\chi^2(2) = 0.46$ [0.796]

Functional Form: $F(69,57) = 1.22$ [0.225]

Wald test for linear restriction:

$F(1,127) = 6.55$ [0.012]*

- Dynamic steady state:

$\Delta p = 0.614 \Delta w + 0.386 \Delta pim$

Table 2.5: Wage-bargaining equation

- Dependent variable: Δw
- Period of estimation: 1959q2 - 1993q4
- Estimated by IV: Instrument used: $\Delta p(-2)$

Variable	Coefficient	t-ratio
Constant	0.0082	5.474
Δw_{t-2}	0.2864	n.a
Δp_t	0.5770	3.092
Δp_{t-1}	0.1366	1.666
$(y - \bar{y})_t$	0.0408	1.680
D74q3	0.0349	3.838
D75q1	0.0464	7.739

$\bar{R}^2 = 0.686$

$SEE = 0.0084$

Serial Correlation: $\chi^2(5) = 8.86$ [0.115]

Heteroscedasticity: $F(11,120) = 0.43$ [0.939]

Normality: $\chi^2(2) = 6.06$ [0.048]*

Functional Form: $F(17,114) = 1.34$ [0.184]

Wald test for linear restriction: $F(1,132) =$

4.19 [0.043]*

- Dynamic steady state:

$\Delta w = 0.011 + \Delta p$

Table 2.6: Import price equation

- Dependent variable: Δp_{im}
- Period of estimation: 1959q2 - 1993q4
- Estimated by IV: Instrument used: $\Delta p(-1)$

Variable	Coefficient	t-ratio
$\Delta p_{im,t-1}$	0.3198	4.284
$\Delta p_{im,t-2}$	0.0884	n.a.
Δp_t	0.3311	2.354
$(\Delta p^* - \Delta e)_t$	0.2607	6.584
D86q487q4	0.0746	8.879

$\overline{R}^2 = 0.472$

$SEE = 0.0212$

Serial Correlation	$\chi^2(5) = 4.18 [0.524]$
Heteroscedasticity	$F(10,123) = 1.85 [0.058]$
Normality	$\chi^2(2) = 23.6 [0.000]**$
Functional Form	$F(18,115) = 4.37 [0.000]**$

Wald test for linear restriction: $F(1,134) = 0.00 [0.99]$

- Dynamic steady state:

$\Delta p_{im} = 0.559 \Delta p + 0.441 (\Delta p^* - \Delta e)$

APPENDIX B: Computing asymptotic forecast variances in a linear RE model

Following Blanchard and Kahn (1980), let us consider the solution of a linear difference model under rational expectations in order to derive, subsequently, its corresponding asymptotic state covariance matrix. In this context, we have to distinguish between predetermined and non-predetermined variables at time t . The former, say y_{t+1} , are function of variables known at time t , that is of variables belonging to the information set at t , regardless the realisations of the variables belonging to the information set at $t+1$. We can render this as follows:

$$y_{t+1} = y_{t+1}^e \equiv E(y_{t+1} | I_t).$$

Non-predetermined variables, say p_{t+1} , on the contrary, can be function of *any* variable in the information set at $t+1$, so that:

$$p_{t+1} = p_{t+1}^e \equiv E(p_{t+1} | I_t).$$

only if the realisations of all variables in I_{t+1} are equal to their expectations conditional on I_t . In view of this distinction, we can therefore define the reduced form of a general linear model including rational agents' expectations as:

$$\begin{bmatrix} y_{t+1} \\ p_{t+1}^e \end{bmatrix} = \Phi \begin{bmatrix} y_t \\ p_t \end{bmatrix} + \Gamma u_t$$

where y_t is an $(n \times 1)$ vector of variables predetermined at t ; p_t is an $(m \times 1)$ vector of variables non-predetermined at t ; p_{t+1}^e is the agents' expectations of p_{t+1} held at t ; u_t is the $(s \times 1)$ vector of structural error terms which, of course, do not feed into the expectational variables; Φ is the $((n+m) \times (n+m))$ matrix of reduced form coefficients, while Γ is the $((n+m) \times s)$ reduced form matrix of coefficients, according to which error terms feed into

predetermined but not expectational variables. Finding a solution (y_t, p_t) to this system amounts to finding a sequence of functions of variables in I_t which satisfies the system itself for all possible realisations of these variables. If we transform Φ into Jordan canonical form, we obtain:

$$\Phi = Q^{-1} \Lambda Q$$

where the eigenvalues of Φ along the diagonal matrix Λ are ordered by increasing absolute value. Λ is further partitioned as:

$$\Lambda = \begin{bmatrix} \Lambda_1 & 0 \\ 0 & \Lambda_2 \end{bmatrix}$$

so that all eigenvalues in Λ_1 are *on or inside* the unit circle, whilst all eigenvalues in Λ_2 lie *outside* the unit circle. Q and Q^{-1} are partitioned accordingly:

$$Q = \begin{bmatrix} Q_{11} & Q_{12} \\ Q_{21} & Q_{22} \end{bmatrix} \quad Q^{-1} = \begin{bmatrix} F_1 & -Q_{11}^{-1}Q_{12}F_2 \\ -F_2Q_{21}Q_{11}^{-1} & F_2 \end{bmatrix}$$

$$\begin{matrix} (n \times n) & (n \times m) \\ (m \times n) & (m \times m) \end{matrix} \quad \begin{matrix} (n \times n) & (n \times m) \\ (m \times n) & (m \times m) \end{matrix}$$

where

$$F_1 = (Q_{11} - Q_{12}Q_{22}^{-1}Q_{21})^{-1}$$

$$F_2 = (Q_{22} - Q_{21}Q_{11}^{-1}Q_{12})^{-1}$$

by applying the inversion rule for partitioned matrices. Blanchard and Kahn prove that:

'If $m=m$, i.e. if the number of eigenvalues of Φ [our symbol] outside the unit circle is equal to the number of non-predetermined variables, then a unique solution exists'.

This solution is forward-looking in the sense that the non-predetermined variables depend on the past only through its effect on the current predetermined variables but not on its effect on the non-predetermined themselves. Namely, the solution yields:

$$y_t = y_0 \quad \text{for } t = 0$$

$$y_t = \Phi_{12} - \Phi_{12} Q_{22}^{-1} Q_{21} y_{t-1} + \Gamma u_t \quad \text{for } t > 0$$

$$p_t = -Q_{22}^{-1} Q_{21} y_t \quad \text{for } t \geq 0$$

By keeping in mind that:

$$\Phi_{11} = F_1 \Lambda_1 Q_{11} - Q_{11}^{-1} Q_{12} F_2 \Lambda_2 Q_{21}$$

$$\Phi_{12} = F_1 \Lambda_1 Q_{12} - Q_{11}^{-1} Q_{12} F_2 \Lambda_2 Q_{22}$$

we obtain:

$$y_t = F_1 \Lambda_1 F_1^{-1} y_{t-1} + \Gamma u_t$$

which can be solved recursively, thereby yielding the general solution of a linear time-invariant discrete-time state system:

$$y_t = F_1 \Lambda_1^t F_1^{-1} y_0 + \sum_{j=0}^{t-1} F_1 \Lambda_1^{t-j-1} F_1^{-1} \Gamma u_j.$$

It follows that:

$$\begin{aligned} p_t &= (-Q_{22} Q_{21} F_1) \Lambda_1^t F_1^{-1} y_0 + \sum_{j=0}^{t-1} (-Q_{22}^{-1} Q_{21} F_1) \Lambda_1^{t-j-1} F_1^{-1} \Gamma u_j \\ &= (-F_2 Q_{21} Q_{11}^{-1}) \Lambda_1^t F_1^{-1} y_0 + \sum_{j=0}^{t-1} (-F_2 Q_{21} Q_{11}^{-1}) \Lambda_1^{t-j-1} F_1^{-1} \Gamma u_j \end{aligned}$$

By construction of Λ_1 , this system is stable or borderline stable⁷. Therefore, as long as $\bar{m} = m$, the asymptotic variance of the predetermined variables will be a finite positive semi-definite matrix, say V_Y , defined as follows:

$$V_Y = \lim_{t \rightarrow \infty} E[y_t y_t'] = \sum_{j=0}^{t-1} \left(F_1 \Lambda_1^{t-j-1} F_1^{-1} \right) \Gamma \Sigma \Gamma' \left(F_1 \Lambda_1^{t-j-1} F_1^{-1} \right)'$$

The asymptotic variance of the expectational values, say V_P , will hence be a finite positive semi-definite matrix too:

$$V_P = \lim_{t \rightarrow \infty} E[p_t p_t'] = \sum_{j=0}^{t-1} \left[\left(-F_2 Q_{21} Q_{11}^{-1} \right) \Lambda_1^{t-j-1} F_1^{-1} \right] \Gamma \Sigma \Gamma' \left[\left(-F_2 Q_{21} Q_{11}^{-1} \right) \Lambda_1^{t-j-1} F_1^{-1} \right]'$$

Hence, it should be fairly evident that, for linear models, stochastic simulation techniques, as long as they involve drawings from the estimated covariance matrix of the historical residuals Σ , will reproduce exactly the same steady-state variances as those we have derived analytically, regardless the presence of forward-looking expectations.

⁷ A careful structure of the model should rule out the presence of exact unit roots; on the other hand, the probability that the latter may arise as numerical coincidence can be assumed to be practically zero.

Chapter Three

Wages, Prices and Inflation-Output Variance Trade-offs: More on Inflation Targetry in the UK

3.1 INTRODUCTION

The macroeconomic models that support the empirical analysis of contemporary economic policy problems have several key features which originate in Denis Sargan's classic Colston paper (Sargan, 1964). Subtitled 'a study in econometric methodology' its primary intention was to develop new econometric methods, and it is the groundwork of modern time-series econometrics. In particular it introduced what subsequently became known as the error-correction model, which allows a representation of both the characteristics of the equilibrium structure of the model and the process of dynamic adjustment. Further buttressed by their role in the burgeoning literature on cointegration, error-correction models are now commonplace in empirical macroeconomics.

Sargan chose the topic of wages and prices so that he could also 'consider practical problems

in the use of the methods in a typical econometric investigation'. His insistence that 'in order to discuss the policy implications of the wage determination equation, it must be considered in relation to a price determination equation' again has wide acceptance nowadays, although the particular perspective has seen substantial evolution.

As we have already discussed in the first chapter of this thesis, the supply side of the economy has received increased attention from empirical modellers since the 1980s for a variety of reasons. The forecasting failures of the demand-oriented models of the 1970s in the face of supply-side shocks, a desire for greater theoretical consistency and a shift in the emphasis of policy all pointed in the same direction. Within a modern macromodelling framework, goods and labour markets are assumed to be imperfectly competitive, and prices are set by firms as a mark-up on costs, given demand; they also set employment, given the wage, which is determined in a bargaining process (see Layard and Nickell, 1985, and Nickell, 1988, for example). An important question is then whether a model possesses a non-accelerating-inflation rate of unemployment (NAIRU), that is, whether the long-run aggregate supply schedule is vertical, and what causes it to shift. This is typically addressed by analysing the core supply-side of the model consisting of the long-run versions of the wage and price equations together with, in an open-economy context, the response of the exchange rate (Joyce and Wren-Lewis, 1991; Turner, 1991). A key requirement is the static homogeneity of the wage and price equations, which again echoes Sargan's preferred specification, the Colston paper having been 'one of the very first to try to make some theoretical sense of the Phillips correlation by pointing out that, at least in the long run, the Phillips curve must be about real and not nominal wages' (Nickell, 1984). It was actually in the course of showing how homogeneity could be achieved by introducing into an equation expressed in differences a term in the levels of the variables that Sargan developed the error-correction model. Whereas the NAIRU may itself depend on the steady-state rate of inflation if the wage and price equations do not in addition exhibit dynamic homogeneity or inflation neutrality, it is often the case that this property does hold, so that the NAIRU is indeed the

‘natural’ rate of unemployment, independent of the inflation rate but affected by supply-side ‘wage-push’ variables. For Sargan, on turning to policy implications, homogeneity led to ‘conclusions which differ fundamentally from those implied by previous investigators. In particular they suggest that the effect of devaluation is only temporary ‘.

In this chapter a model of wages and prices is constructed, drawing on the tradition initiated by Sargan’s Colston paper, reinterpreted as discussed above. The model is then completed with an aggregate demand equation and an exchange rate equation, and used to study the performance of interest rate rules for targeting inflation. Nevertheless, in order to illustrate the role of monetary policy rules in stabilising inflation around its target path and therefore to make it possible to compare a range of monetary policy rules, a model needs to fulfil certain conditions. What we actually aim to emphasise in this chapter is the fact that not *any* model which is data consistent is also suitable for policy evaluation (in the specific context, for the assessment of monetary policy rules).

In fact, since monetary policy has been explicitly focused on the control of inflation in several OECD countries including the United Kingdom (see section 2.1), there exists a growing literature assessing the statistical performance of different policy regimes through the application of appropriate analytic or numerical techniques to macroeconomic models. An important precursor is the classic article by Taylor (1979), who estimates a simple econometric model of the US economy with rational expectations, uses it to calculate optimal monetary policy rules to stabilise fluctuations in output and inflation, and hence defines and estimates a long-run trade-off between the variability of inflation and of output. The subsequent literature contains a wide variety of applications, to large-scale economy-wide econometric models or small stylised models, with forward-looking or backward-looking expectations, using counterfactual simulation – deterministic or stochastic – or analytic methods, with simple feedback policy rules or full optimisation, and for several countries.

However, as it has already been stressed in the previous chapter, if the macromodel underpinning the analysis lacks satisfactory first-moment properties, then it is very much unlikely that it may sustain reliable second-moment calculations. For this reason, in this chapter we allow for a more complete integration of steady-state properties and short-run dynamic adjustments within our estimated model. Careful attention is also granted to both statistical and economic issues, by recognising the policy implications of our empirical study.

Let us consider, for instance, the monetary transmission channels and the role of inflation targeting in this regard. In a closed economy, standard transmission channels comprise an aggregate demand channel and an expectations channel. Through the aggregate demand channel, monetary policy affects spending components and, possibly, the availability of credit, via its effects on the short term real interest rate. Aggregate demand then affects inflation via the Phillips curve. The expectations channel, on the other hand, allows monetary policy to affect inflation expectations which, in turn, affect inflation via the wage-price system. In an open economy, there are additional channels for the transmission of monetary policy. The exchange rate is affected by policy rate setting via the interest rate differential, if an interest parity condition holds. With sticky prices, nominal exchange rate affects the real interest rate. The real exchange rate will have an effect on competitiveness which, in turn, will affect both domestic and foreign demand for domestic goods and hence contribute to the aggregate demand channel of monetary policy. Furthermore, the exchange rate influence directly domestic currency prices of imported final goods, which enter the CPI inflation. Typically, the lag of this direct exchange rate channel is considered to be shorter than that of aggregate demand channel. Hence, monetary policy can affect CPI inflation with a shorter lag whenever exchange rate movements are taken into account. Ruling out from a model an exchange rate transmission channel or, equally, downgrading the role of credibility by ignoring markets' expectations may then lead to a wrong assessment of the performance of any monetary policy rule.

Besides providing a sounder theoretical and empirical framework to previous chapter's results, we also intend to investigate the macroeconomic consequences of a range of different model specifications. In particular, crucial in the relation between monetary policy and the inflation process is the question of whether monetary policy should react 'strictly' to inflation or whether it should also consider other macroeconomic indicators while making policy decisions. Svensson's (1998a) argument for 'inflation forecast' targeting implies that the central bank should use all relevant information in implementing policy actions. Haldane and Batini (1998) seem to confirm this hypothesis: on the basis of stochastic simulation of a calibrated model of the UK, they show that strict inflation forecast targeting outperforms Taylor-type rules. According to the authors, the result gets even stronger the more the private sector (i.e. the labour market) is backward-looking. However, Haldane and Batini's result could also be explained by the fact that forward-looking rules are simply likely to smooth out the effects of temporary shocks, while this is not the case with respect to current measures of inflation. Levin *et. al* (1998) simulate a closed-economy model with smoothed inflation targeting rules: under these circumstances they find that the degree of forward-lookingness of the monetary authority does not make much difference. Rothenberg and Woodford (1998) also point out the irrelevance of forward-lookingness in inflation targets, as far as the public is assumed to be 'rational' and policy credible (on the same argument, see Wouters and Dombrecht, 1999). As the issues look then strictly interrelated, we also analyse the impact of different degrees of forward-lookingness in both inflation targeting horizon and wage bargaining on the effectiveness of monetary policy. Moreover, two alternative forms of interest rate feedback rule and various parametrisations are considered, thereby allowing for different extent of policy activism and response 'smoothness'.

Although econometrically estimated, the macromodel used in this chapter remains in the 'small stylised model' tradition and is a considerable simplification compared to the large-scale economy-wide models used in practical policy analysis and forecasting; nevertheless some of its features mimic those of HM Treasury's model of the UK economy (Chan et al.,

1995), and we use the Treasury model dataset. The model is essentially linear; hence, the analytical method developed in chapter 2 for the calculation of asymptotic standard errors in forward-looking models can also be employed in this context. The econometric modelling exercise is described in Section 3.2 and inflation targetry in Section 3.3. The implications of the analysis are discussed in Section 3.4.

3.2 MODELLING WAGES AND PRICES

We focus on the same wage and price variables as Haldane and Salmon (1995), namely nominal per capita earnings and the GDP deflator, in Treasury nomenclature ERPR and PPGDP (all variable definitions are given in the appendix). We consider error-correction formulations to describe both long-run and short-run features of the models. This is done in a single-equation context, for two reasons. First is the ‘curse of dimensionality’: the number of variables is too great for successful implementation of the VAR-based procedures of Johansen (1988). Second is the fact that several of the variables under consideration show considerable persistence but cannot be pure integrated processes: this is obvious in the case of rates of unemployment and taxation, while the weight of evidence is moving in the same direction in respect of the real exchange rate, that is, in favour of purchasing power parity as a long-run relation, albeit one from which deviations exhibit long-memory properties (Rogoff, 1996). In such circumstances we note the finding of Gonzalo and Lee (1998) that the original test procedures of Engle and Granger (1987) may be more robust than those of Johansen.

3.2.1 *The price equation*

Prices are determined as a mark-up on costs, with the mark-up a negative function of the demand elasticity. Whether this is pro-cyclical or counter-cyclical is uncertain theoretically, and empirical evidence is often ambiguous, nevertheless we find a significant positive effect for a measure of capacity utilisation in manufacturing, which we treat as the predominant sector in price formation. The equation also includes a term in the variance of price inflation, taken as a proxy for the effect of uncertainty on producers’ margins, as in the Treasury model. The Treasury’s cost variable is approximated as a weighted average, with weights

summing to one, of unit labour costs and import prices. The estimated long-run equations are given in Table 3.1. These are found to be statically homogeneous, with stationary errors.

Table 3.1 Domestic price inflation equation

<u>Long-run equations:</u>	
$\log(MCOST) = - 1.37 + 0.300 \log(PMBM) + 0.700 \log(\frac{ERPR(1 + TE)}{PRODS})$	
SEE =	0.0261
CRDW =	0.254
ADF(2) =	-2.76
$\log(PPGDP) = - 0.047 + \log(MCOST) - 0.0019 SVPPGDP + 0.296 \log(\frac{YMF}{YMF^*})$	
SEE =	0.0584
CRDW =	0.112
ADF(5) =	-2.04
<u>Constrained LS estimates - Period of estimation: 1975q4-1997q1</u>	
$\Delta \log (PPGDP)_t = 0.005 + 0.178 \Delta \log (PPGDP)_{t-1}$	
(0.001) (0.091)	
+ 0.126 $\Delta \log (PPGDP)_{t-2}$ + 0.091 $\Delta \log (PPGDP)_{t-3}$	
(- -) (0.084)	
+ 0.148 $\Delta \log (MCOST)$ + 0.040 $\Delta \log (MCOST)_{t-1}$	
(0.059) (0.059)	
+ 0.167 $\Delta \log (MCOST)_{t-2}$ + 0.250 $\Delta \log (MCOST)_{t-3}$	
(0.059) (0.070)	
- 0.156 $\Delta \log (\frac{YMF}{YMF^*})_{t-4}$ - 0.150 $\Delta^2 \log (MCOST)_{t-3}$	
(0.095) (0.037)	
- 0.048 [$\log(PPGDP) - \log(MCOST) + 0.047 + 0.0019 SVPPGDP - 0.296 \log(\frac{YMF}{YMF^*})$] _{t-1}	
(0.017)	
+ 0.033 <i>d78p1</i>	
(0.008)	
SEE =	0.0073
AR F(5, 70) =	1.3322 [0.2608]
Normality $\chi^2(2)$ =	4.5223 [0.1042]
ARCH F(4, 67) =	1.1081 [0.3601]
Heterosc. F(21, 53) =	0.60233 [0.8986]
LR test of restrictions: $\chi^2(1) = 2.41883$ [0.1199]	

Specification of the dynamic equation follows the general-to-specific approach, with the general model extended to include the possibility of forward-looking behaviour by price setters. The preferred form (reported in the table) includes three lags of inflation, together with lagged cost terms, a term in the aggregate output gap and the error correction term. It exhibits dynamic homogeneity, that is, the long-run solution is independent of the steady-state inflation rate¹.

3.2.2 *The wage equation*

The wage equation is generated by a collective bargaining model, as discussed by Layard and Nickell (1985). Whereas wage negotiations typically focus on the nominal wage, employers and employees are not insensitive to inflation, but different real wage concepts are relevant to their objectives. For employers, what matters are their real wage costs, namely nominal wages plus employers' taxes deflated by producer prices, whereas employees focus on the real consumption wage, namely nominal wages less direct taxes deflated by consumer prices. Thus taxes and the relative price of imports drive a 'wedge' between the two wage concepts. The incidence of taxation, or the degree of real wage resistance, can then only be assessed in an equation which has one or other of the two real wage variables as the dependent variable: our long-run equation is formulated in terms of employers' real wage costs. It contains no significant long-run wedge effect, otherwise real earnings track productivity and are negatively influenced by the unemployment rate and positively by a term in union density, proxying union power. The estimated long-run equation is shown in Table 3.2. Putting this equation alongside the long-run price equation, their mutual static homogeneity implies the existence of a NAIRU, with unemployment

¹ It should be noticed that in the current specification of the price equation there is no evidence of residual heteroscedasticity. This appears to contradict our findings in chapter 2. However, the more complete integration of the long run through the error correction specification, the explicit inclusion of the variance of price inflation in the equilibrium term and the use of a shorter estimation period, should help explaining such seeming contradictory result.

related to the ‘wage-push’ union density variable and the inflation variance term.

Table 3.2 Earning inflation equation

Long-run solution:

$$\log\left(\frac{ERPR(1+TE)}{PRODS}\right) = 2.41 + \log(PPGDP) - 0.021 \log(U)_{t-4} + 0.538 \log(UDEN)_{t-4}$$

SEE = 0.0192
 CRDW = 0.441
 ADF(5) = -4.12

(i) Backward-looking dynamic bargaining specification

Constrained IV estimates - Period of estimation: 1975q4-1997q2

Additional instrument used: Fitted values from domestic price inflation equation (1)

$$\begin{aligned} \Delta \log[(ERPR)(1+TE)]_t &= 0.071 \Delta \log[(ERPR)(1+TE)]_{t-1} + 0.336 \Delta \log[(ERPR)(1+TE)]_{t-2} \\ &\quad (0.095) \qquad \qquad \qquad (0.095) \\ &+ 0.407 \Delta \log(PRODS)_t + 0.347 \Delta \log(PPGDP)_t \\ &\quad (0.095) \qquad \qquad \qquad (--) \\ &+ 0.205 \Delta \log(PPGDP)_{t-1} + 0.031 \Delta \log(PPGDP)_{t-2} \\ &\quad (0.096) \qquad \qquad \qquad (0.100) \\ &+ 0.010 \Delta \log(PPGDP)_{t-3} + 0.098 \Delta \log(WEDGE)_{t-4} \\ &\quad (0.090) \qquad \qquad \qquad (0.053) \\ &- 0.259 \left[\log\left(\frac{ERPR(1+TE)}{PRODS}\right)_{t-1} - 2.41 - \log(PPGDP)_{t-1} + 0.021 \log(U)_{t-5} - 0.538 \log(UDEN)_{t-5} \right] \\ &\quad (0.052) \\ &- 0.013 d77p3 \\ &\quad (0.008) \end{aligned}$$

SEE = 0.0074
 AR F(5, 71) = 1.3745 [0.2442]
 Normality $\chi^2(2)$ = 0.45609 [0.7961]
 ARCH F(4, 68) = 0.45243 [0.7703]
 Heterosc. F(19, 56) = 1.7656 [0.0516]

LR test of restrictions: $\chi^2(1) = 2.06424$ [0.1508]

Table 3.2 Earning inflation equation (continued)

(ii) 1-quarter forward-looking dynamic bargaining specification

Constrained IV estimates - Period of estimation: 1975q4-1997q1

Additional instrument used: Fitted values from domestic price inflation equation (1)

$$\begin{aligned} \Delta \log[(ERPR)(1+TE)]_t = & 0.006 + \Delta \log(PPGDP)_{t+1} \\ & (0.003) \text{ (---)} \\ & + 0.165 \Delta \log(PRODS)_t + 0.139 \Delta \log(WEDGE)_{t-4} \\ & (0.125) \quad (0.065) \\ & - 0.157 \left[\log\left(\frac{ERPR(1+TE)}{PRODS}\right)_{t-1} - 2.41 \cdot \log(PPGDP)_{t-1} + 0.021 \log(U)_{t-5} - 0.538 \log(UDEN)_{t-5} \right] \\ & (0.069) \end{aligned}$$

SEE = 0.0098
AR F(5, 76) = 0.70257 [0.6232]
Normality $\chi^2(2)$ = 0.63535 [0.7278]
ARCH F(4, 73) = 0.15273 [0.9612]
Heterosc. F(8,72) = 0.63591 [0.7450]

LR test of restrictions: $\chi^2(1) = 0.93572$ [0.3334]

(iii) 2-quarter forward-looking dynamic bargaining specification

Constrained IV estimates - Period of estimation: 1975q4-1996q4

Additional instrument used: Fitted values from domestic price inflation equation (1)

$$\begin{aligned} \Delta \log[(ERPR)(1+TE)]_t = & 0.004 + \Delta \log(PPGDP)_{t+2} \\ & (0.003) \text{ (---)} \\ & + 0.203 \Delta \log(PRODS)_t + 0.093 \Delta \log(WEDGE)_{t-4} \\ & (0.125) \quad (0.067) \\ & - 0.111 \left[\log\left(\frac{ERPR(1+TE)}{PRODS}\right)_{t-1} - 2.41 \cdot \log(PPGDP)_{t-1} + 0.021 \log(U)_{t-5} - 0.538 \log(UDEN)_{t-5} \right] \\ & (0.072) \\ & - 0.036 d77p3 \\ & (0.011) \end{aligned}$$

SEE = 0.0097
AR F(5, 76) = 0.67002 [0.6474]
Normality $\chi^2(2)$ = 5.3344 [0.0694]
ARCH F(4, 73) = 0.4224 [0.7920]
Heterosc. F(8, 72) = 0.7149 [0.6934]

LR test of restrictions: $\chi^2(1) = 0.017409$ [0.8950]

We also note that the wage equation is dynamically homogeneous with respect to prices but not productivity. Thus the NAIRU is independent of the steady-state inflation rate and so is the ‘natural’ rate of unemployment, but productivity growth has a long-run effect, consistent with evidence presented by Manning (1992) that the slowdown in productivity growth is an important explanation of the increase in unemployment in many OECD countries.

In the framework of a wage-bargaining process we consider a range of overlapping contracts models in line with Fuhrer and Moore (1995), which reflect the fact that wage contracts remain in effect for a number of periods hence nominal wages are fixed in the short run, and that different groups negotiate at different points in time. The observed aggregate nominal wage is then an average of wages negotiated at different points in time, while rational agents having *relative* real wages in mind may also be forward-looking in prices. Accordingly we consider specifications in which prices lead wages by zero, one or two quarters and in which the short-run dynamics of nominal wages and prices may not coincide, although we always retain static homogeneity. The evidence is that the short-run dynamics do indeed differ, while the data cannot discriminate between different degrees of forward-lookingness. Such a flexible mixed lag/lead specification, allowing for a variable and data-determined degree of indexation in real terms, is appealing for mainly two reasons. Firstly, it generates inflation persistence, contrary to conventional two-period Taylor (1979) contracting models, which instead induce only price-level persistence. Secondly, it permits to test for different expectation horizons in the wage-bargaining process. The impact of this on policy issues discussed in Section 3.3 is an important question, and we retain all the three specifications given in Table 3.2, for the time being. As noted above, dynamic homogeneity is data-admissible, and difference terms in productivity and the wedge are also part of the dynamic equations.

3.2.3 Other equations

We first summarise the aggregate demand side of the model with an equation relating actual output to potential output, estimated as a linear trend, and the real interest rate. Although the output gap is obviously a short-run concept in economic terms, our quarterly measure is highly persistent, hence our statistical model is again of error-correction form. The real interest rate is defined in terms of forward-looking inflation, and the expected appreciation of the exchange rate also enters the dynamic equation. Details can be found in Table 3.3.

Table 3.3 Output gap equation

Long-run solution:

$$\log\left(\frac{YMF}{YMF^*}\right) = 0.085 - 4.49 \left[\frac{RS}{400} - \Delta \log(PPGDP) \right]$$

IV estimates - Period of estimation: 1975q1-1997q1

Additional instrument used: Lagged nominal domestic interest rate and fitted values from domestic price inflation equation (1)

$$\Delta \log\left(\frac{YMF}{YMF^*}\right)_t = 0.004 - 0.052 \Delta \log(Q)_{t-1}$$

(0.002) (0.020)

$$- 0.049 \log\left(\frac{YMF}{YMF^*}\right)_{t-4} - 0.219 \left[\frac{RS}{400} - \log\left(\frac{(PPGDP)^e_{t+1}}{PPGDP}\right) \right]_{t-1}$$

(0.018)

(0.108)

$$+ 0.044 d79p2 - 0.043 d79p3 - 0.057 d75p2 - 0.040 d80$$

(0.011)

(0.012)

(0.012)

(0.006)

SEE = 0.0111
AR F(5, 77) = 0.36019 [0.3563]
Normality $\chi^2(2)$ = 0.30854 [0.2430]
ARCH F(4, 74) = 0.078465 [0.5536]
Heterosc. F(10, 71) = 0.80467 [0.1935]

Finally, in an open-economy context, we represent the exchange rate transmission channel by including equations for import prices and the exchange rate itself. Import prices are determined as a lagged pass-through of world tradeables prices in domestic currency. For the

sterling effective exchange rate index we find that the forward-looking uncovered interest parity or open arbitrage condition is data-admissible. Corresponding estimation results are summarised in Tables 3.4 and 3.5, respectively.

Table 3.4 Import price inflation equation

Long-run equation:

$$\log(PMBM) = \log\left(\frac{WPXM}{RX}\right)$$

LS estimates - Period of estimation: 1975q3-1997q2

$$\Delta \log(PMBM)_t = \Delta \log\left(\frac{WPXM}{RX}\right)_t + 0.573 - 0.0008 \text{ Trend}$$

(0.164) (0.0003)

$$- 0.105 [\log(PMBM) - \log\left(\frac{WPXM}{RX}\right)]_{t-4} - 0.135 d78p1 - 0.137 d92p3$$

(0.031) (0.053) (0.053)

SEE =	0.0526
AR F(5, 78) =	0.54252 [0.7435]
Normality $\chi^2(2)$ =	0.39215 [0.8136]
ARCH 4 F(4, 75) =	0.11932 [0.9421]
Heterosc. F(6, 76) =	1.6694 [0.1401]

Table 3.5 Uncovered Interest Parity equation

Constrained IV estimates - Period of estimation: 1974q1-1997q1

Additional instrument used: Lagged nominal domestic interest rate and lagged inflation rate

$$\Delta \log(Q)_{t+1}^e = \log\left\{ \left[1 + \left(\frac{RS_t}{400} - \log\left(\frac{(PPGDP)_{t+1}^e}{PPGDP} \right) \right) \right] / \left[1 + \left(\frac{ROSHT_t}{400} - \log\left(\frac{(WPXM)_{t+1}^e}{WPXM} \right) \right) \right] \right\}$$

(--)

+0.112 d92p3

(0.036)

SEE	= 0.0359
AR F(5, 86)	= 1.4862 [0.2027]
Normality $\chi^2(2)$	= 1.8614 [0.3943]
ARCH F(4, 83)	= 0.46102 [0.7641]
Heterosc. F(3, 87)	= 0.3226 [0.8090]

LR test of restrictions: $\chi^2(1) = 0.35668$ [0.5504]

3.3 INFLATION TARGETRY

3.3.1 Policy rules

To study a monetary policy regime of inflation targeting, the five-equation model of Section 3.2 is closed with an interest rate feedback rule. We consider various parameterisations of two general forms of rule. The first is a ‘difference’ rule of the form

$$\Delta i_t = \lambda(E_t \pi_{t+j} - \pi^T) + \mu(y_t - y^T) \quad (3.1)$$

and the second is a ‘level’ or ‘Taylor’ rule of the form

$$i_t = r^* + E_t \pi_{t+1} + \lambda(E_t \pi_{t+j} - \pi^T) + \mu(y_t - y^T) \quad (3.2)$$

where i is the nominal interest rate, r^* is the equilibrium real interest rate, y is the output gap and the inflation rate π is defined as $\Delta \log(PPGDP)$; superscript T denotes target values. Three cases of each rule arise as j takes the value 0, 1 or 2. If $j=0$, then $E_t \pi_t$ is simply π_t , and this is a simple contemporaneous rule, adjusting interest rates whenever inflation deviates from its target. If $j>0$, we have a forward-looking rule which is probably closer to central bank practice, and such ‘inflation forecast targeting’ rules have been extensively analysed by Svensson (1997). Different values of λ and μ are considered below, including $\mu=0$, which reduces each rule to an ‘inflation-only’ rule.

The general characteristics of (3.1) and (3.2), discussed by Leith and Wren-Lewis (1996), for example, are first, that the difference rule (3.1) implies that any shock to the price level is completely reversed, for any constant inflation target, whereas (3.2) implies that past deviations of the price level are neglected: bygones are bygones. Secondly, (3.1) implies that inflation overshoots whenever the inflation target is altered, whereas (3.2) implies monotonic adjustment.

3.3.2 *Model properties*

The six-equation model comprising the five equations estimated in Section 3.2 and policy rule (3.1) or (3.2) contains rational expectations of one or two future-dated variables: the exchange rate and, depending on the specification of the earnings equation and the policy rule, inflation. It is linear in the variables of concern, once the first difference of the logarithm of the price level is equated to the inflation rate, for example, and so can be analysed using the solution methods of Blanchard and Kahn (1980). In each specification, the number of eigenvalues outside the unit circle (one or two) is equal to the number of 'non-predetermined' variables of the model, hence it is saddlepath stable.

We undertake a simple check on the properties of the model via deterministic simulation², using inflation-only contemporaneous rules ($\mu = 0, j = 0$). The experiment considers the effect of a reduction in the inflation target, a simulation used for comparative purposes by Church et al. (1996, 1997, 2000). They find that in the NIESR model of the UK economy, for example, this produces the same reduction in actual inflation, with a long-run reduction in the nominal interest rate also of the same amount, leaving the real rate of interest unchanged, as in a standard Dornbusch model. The inflation target is set at one-quarter percentage point below base-run inflation throughout the simulation period (1973q2-1999q3).

The results in Figure 3.1 (with $\lambda=0.2$) show a long-run inflation response of the same amount, with the level rule (3.2) producing a slower but smoother response and much lower output costs of disinflation. As in the NIESR model, the forward-looking UIP condition results in an immediate jump in the exchange rate, the announcement of the new target being fully credible. That is, the exchange rate adjusts immediately to clear the asset market for any given rate of inflation, whereas goods market equilibrium is only achieved in the long run due to the inertia that characterises the inflation process. The initial inflation rate is in

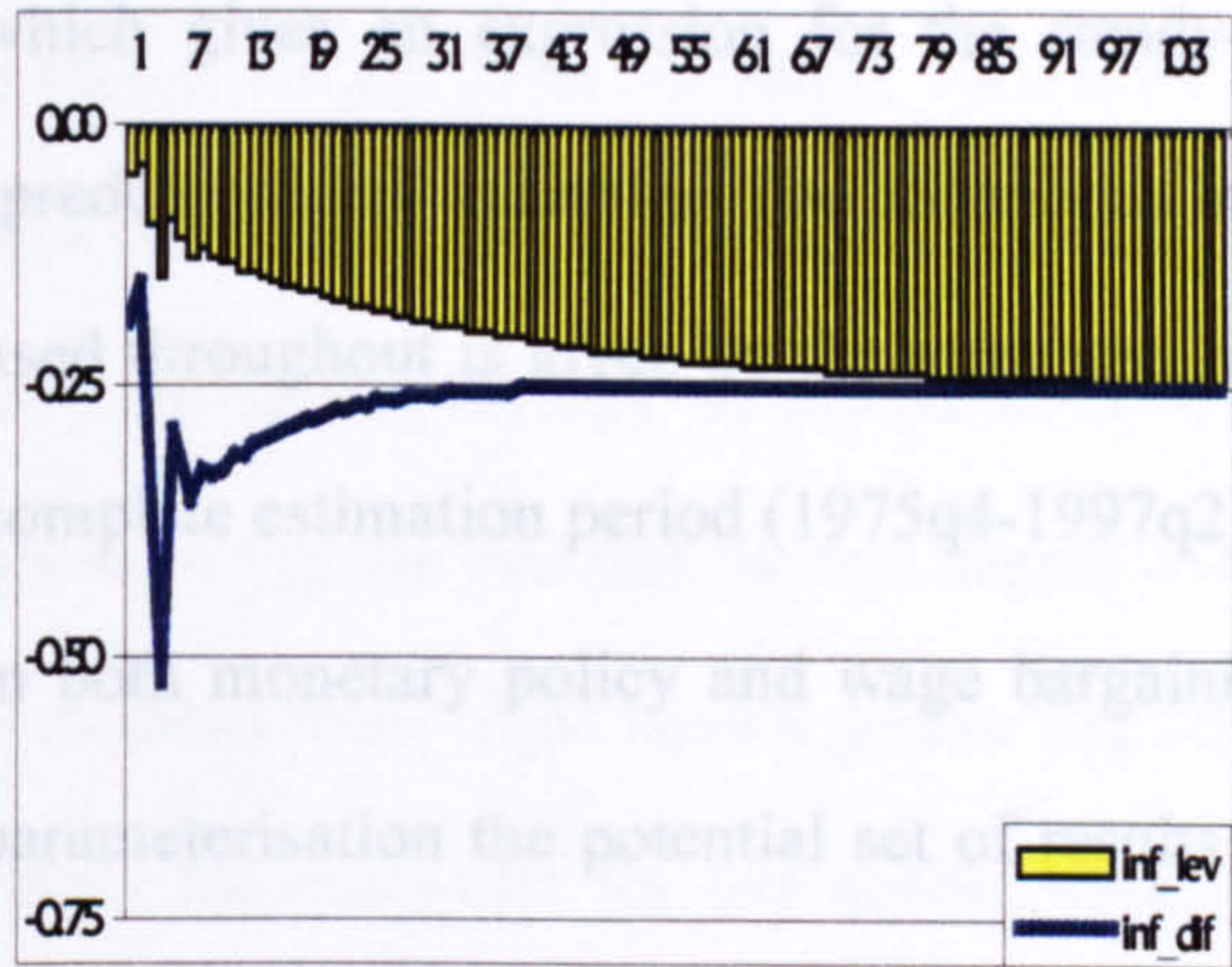
² Deterministic simulations of the model have been performed using WINSOLVE software.

fact too high with respect to the new target value, thereby leading to increases in interest rates and to expected exchange rate appreciation, both of which cause implicit capital inflows and spot rate appreciation. Since the initial rise in interest rates required by the level rule (3.2) is relatively small, the corresponding exchange rate jump is also much smaller. Although the eventual exchange rate appreciation proceeds at the same rate irrespective of the rule, this initial difference explains the apparent divergence in the lower panel of Figure 3.1.

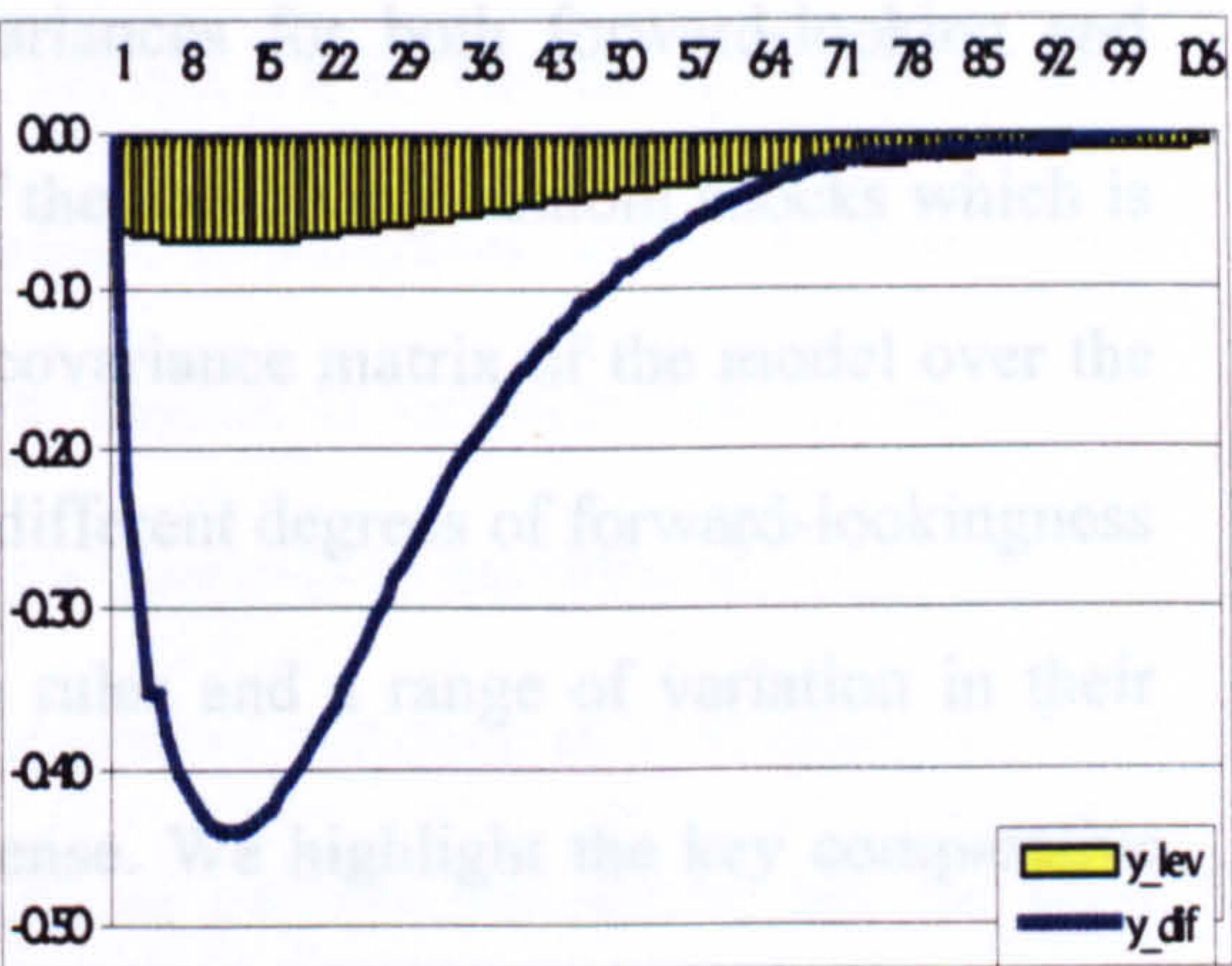
This experiment confirms properties of the model that originate in its econometric specification in Section 3.2, and confirms its suitability for the variance calculations which follow. Consistently with our *a-priori*, according to which a model without satisfactory first-moment properties can hardly sustain reliable second-moment calculations, we find that the same simulation produces nonsensical results in the model of Haldane and Salmon (1995), with increases in interest rates beyond reason.

Figure 3.1 Disinflation experiment under difference and level rule
(reduction of 1/4 percentage point in the inflation target)

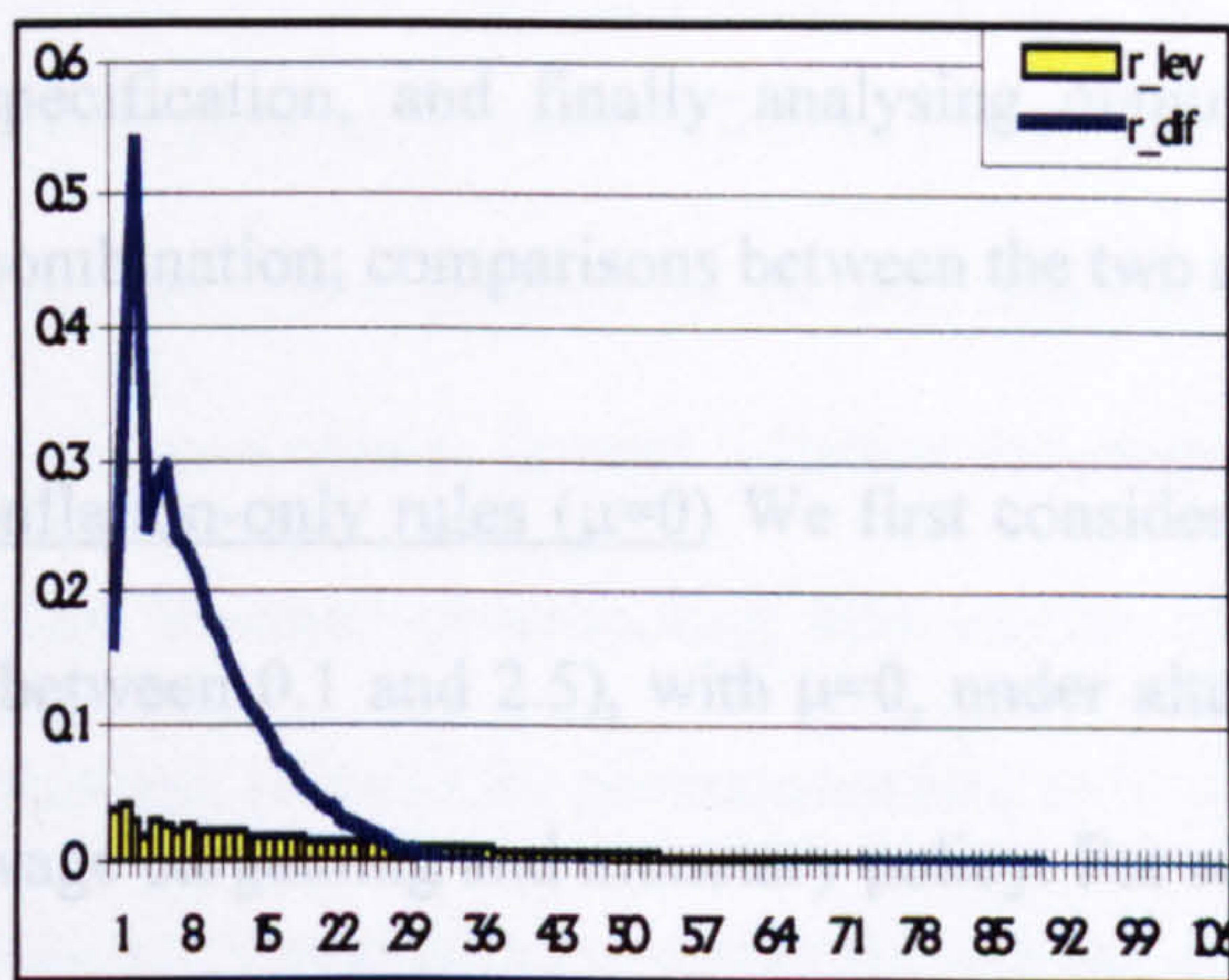
Inflation response



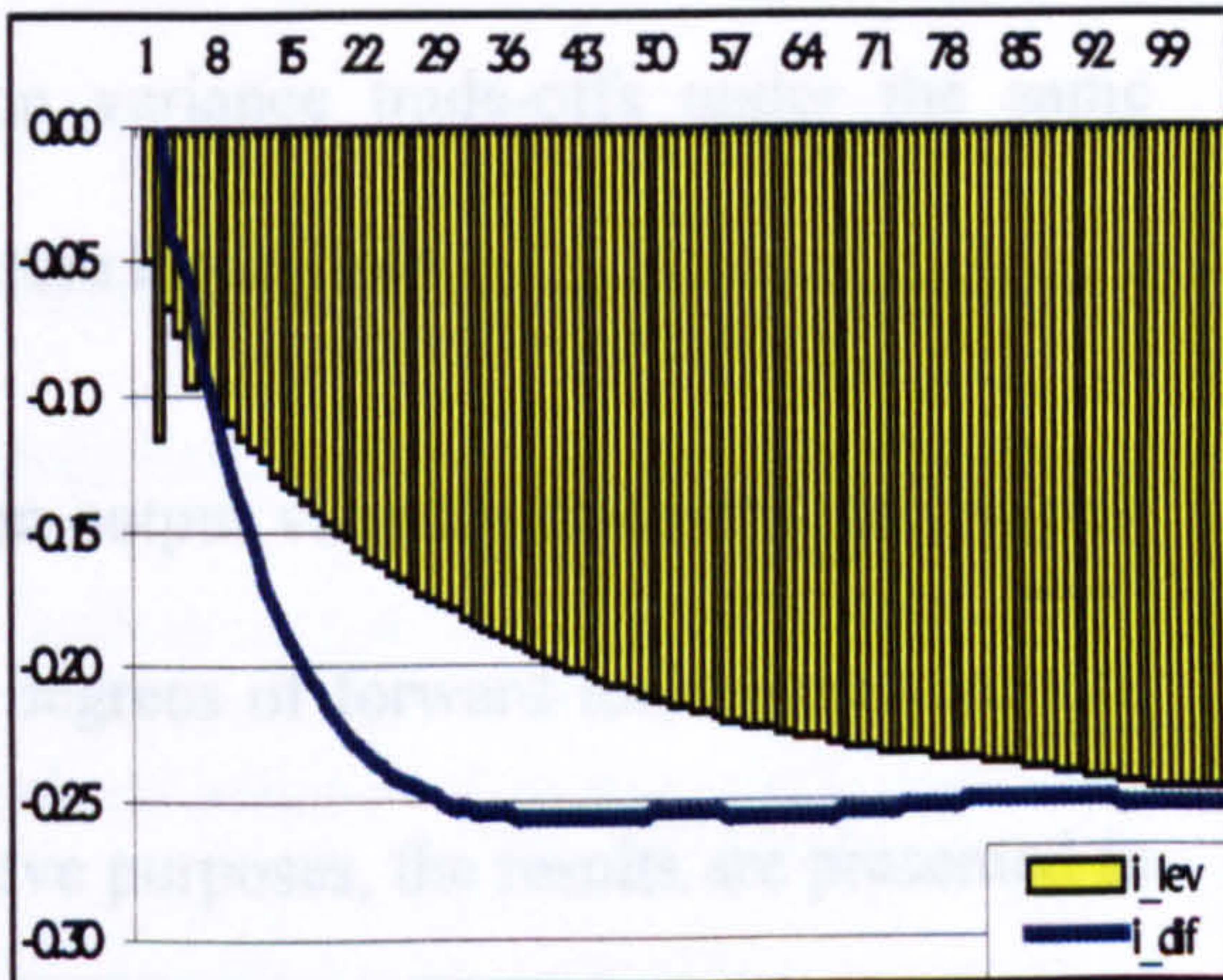
Output response



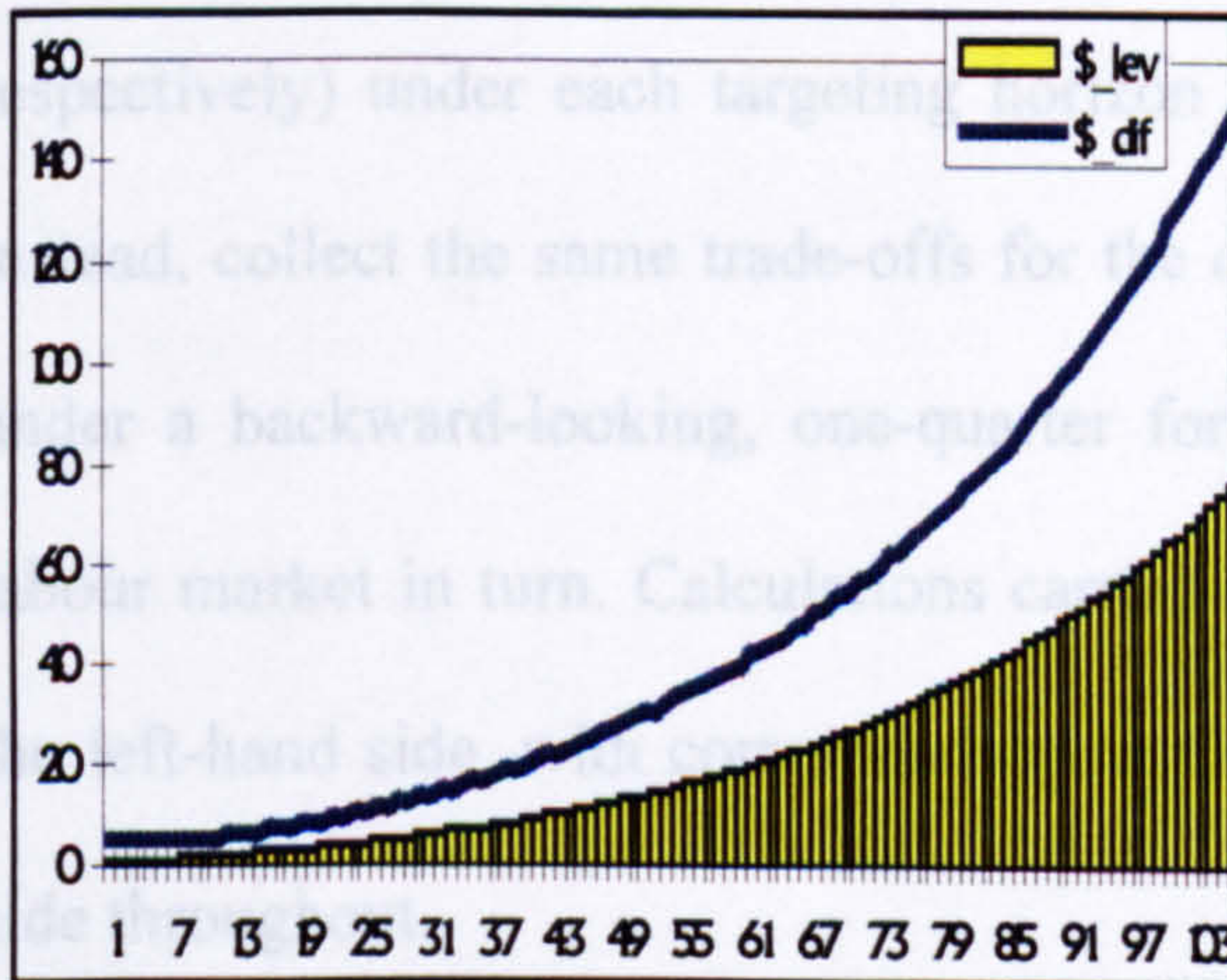
Real interest rate response



Nominal interest rate response



Nominal exchange rate response



Note: All responses are expressed as deviations from base in percentage points, with the exception of nominal exchange responses which are given in percentage deviations from baseline.

3.3.3 *The variance of inflation and output*

Calculation of variances for our linear rational expectations model rests on extensions of the Blanchard-Kahn analytical solution methods, as described in the appendix to chapter 2, which gives an expression for the steady-state variances for both forward-looking and ‘predetermined’ variables. The covariance matrix of the underlying random shocks which is used throughout is given by the estimated residual covariance matrix of the model over the complete estimation period (1975q4-1997q2). With different degrees of forward-lookingness in both monetary policy and wage bargaining, two rules and a range of variation in their parameterisation the potential set of results is immense. We highlight the key comparative questions by first considering inflation-only rules ($\mu = 0$), then showing the sensitivity of outcomes to variation in λ and μ for one particular monetary policy/wage bargaining specification, and finally analysing output-inflation variance trade-offs under the same combination; comparisons between the two rules feature throughout.

Inflation-only rules ($\mu=0$) We first consider inflation-output variance trade-offs as λ varies (between 0.1 and 2.5), with $\mu=0$, under alternative degrees of forward-lookingness in both wage bargaining and monetary policy. For comparative purposes, the results are presented in two different ways: Figures 3.2-3.4 plot inflation and output steady-state standard errors for the different inflation horizons in wage bargaining (denoted as ‘*blw*’, ‘*1flw*’ and ‘*2flw*’, respectively) under each targeting horizon j for monetary policy in turn; Figures 3.5-3.7, instead, collect the same trade-offs for the different targeting horizons considered ($j=0,1,2$) under a backward-looking, one-quarter forward-looking and two-quarter forward-looking labour market in turn. Calculations carried out under difference rules (3.1) are reported on the left-hand side, with corresponding results for level rules (3.2) plotted on the right-hand side throughout.

We first focus on figures 3.2-3.4. The range of variation in output steady-state standard errors is very small, since policy does not respond to output deviations. Nevertheless, the

most striking feature is the outlying trade-off in the South-West corner that is obtained for any monetary rule implemented under backward-looking wage bargaining. This suggests that, whenever the labour market is backward-looking, monetary policy is better able to achieve inflation stabilisation. Under these circumstances, inflation standard errors range between 1-1.2% whereas output variability remains around 3.2%. The design of the policy rule itself (difference or level) and its degree of forward-lookingness appear to make very little difference here. If, on the other hand, the labour market is forward-looking, then both the set-up of the rule and its own degree of forward-lookingness in accommodating inflation deviations from target have a greater impact, yielding greater variation in outcomes. In these cases, the trade-offs for one-quarter-ahead bargaining in general lies above that for two-quarter-ahead bargaining, although the differences are small. However, as Figures 3.6 and 3.7 show, under difference rules (3.1) targeting inflation forecast deviations appears to be, *ceteris paribus*, a more efficient policy than accommodating to current inflation deviations. This may be explained by the fact that reactions to longer-horizon disequilibria may induce some smoothness in both inflation and output responses under such rules, thereby correcting their inherent overshooting and excess of policy activism. On the contrary, with level feedback rules (3.2), accommodating to two-quarter-ahead inflation deviations is more costly than accommodating to contemporaneous deviations.

Figure 2.2. Inflation-output standard error trade-offs under contemporaneous inflation-only rules

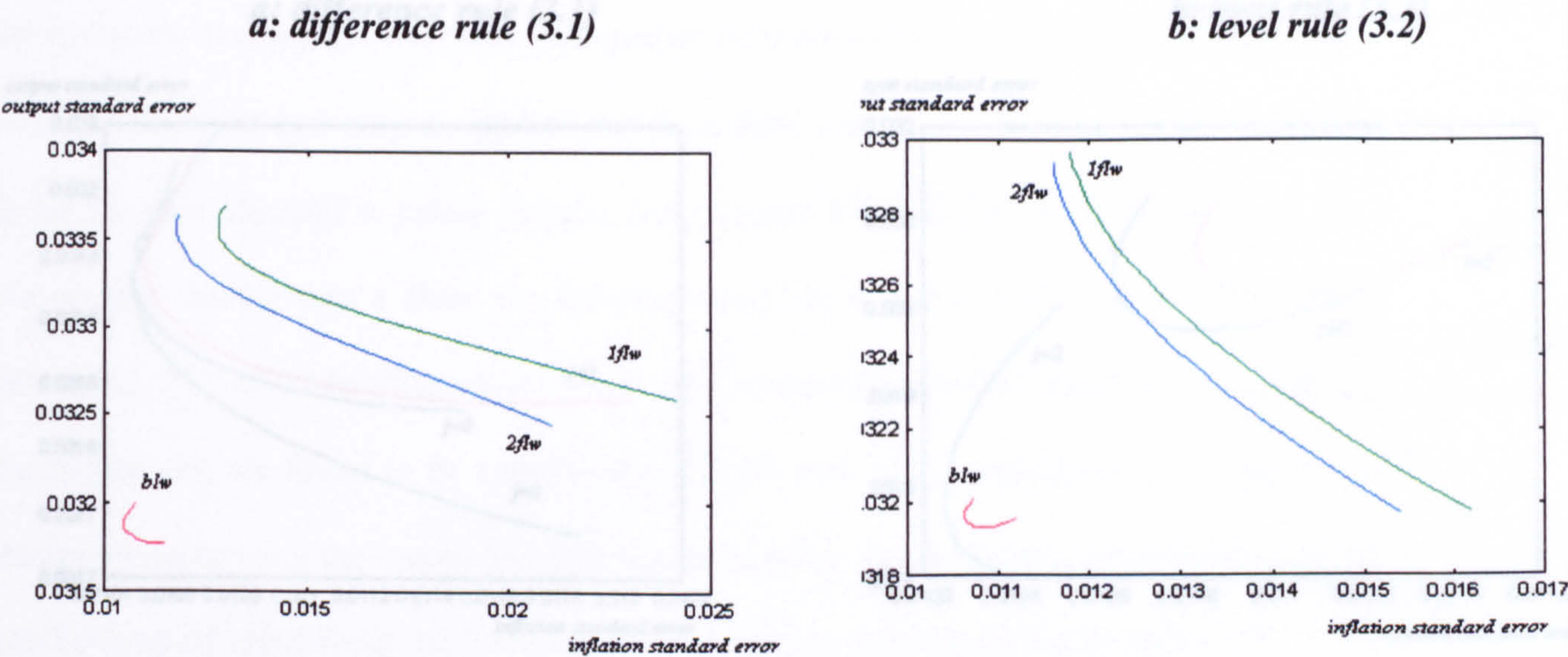


Figure 3.3 Inflation-output standard error trade-offs under 1-quarter forward-looking inflation-only rules

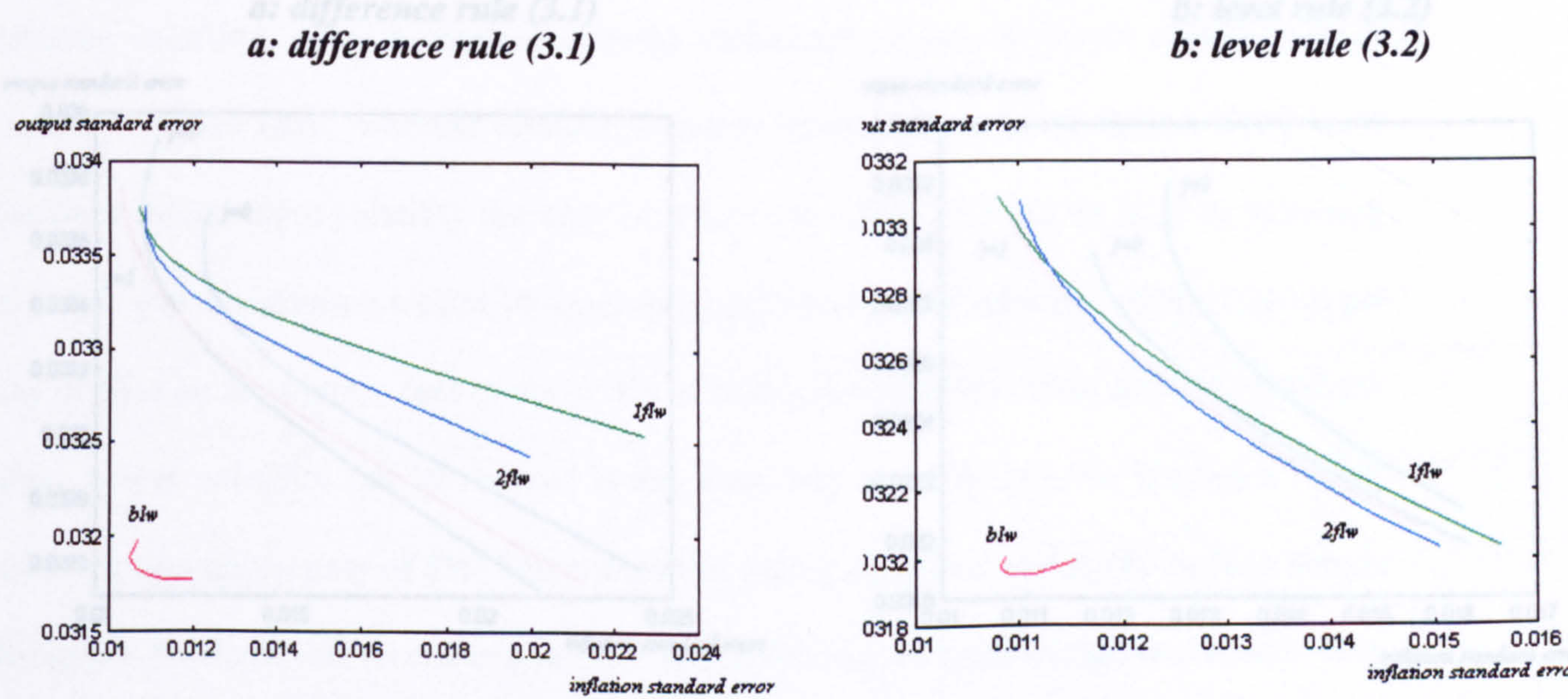
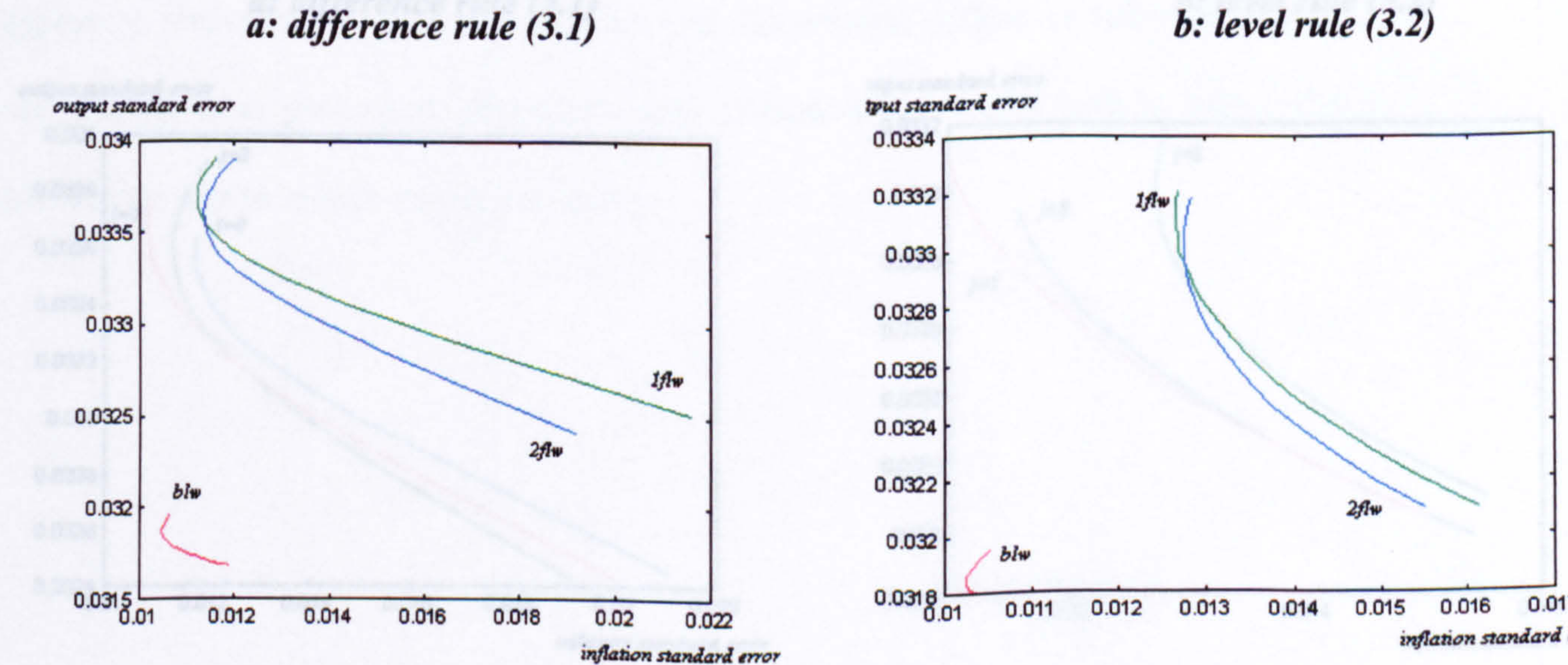


Figure 3.4 Inflation-output standard error trade-offs under 2-quarter forward-looking inflation-only rules



**TEXT CUT
OFF IN
ORIGINAL**

Figure 3.5 Inflation-output standard error trade-offs under backward-looking wage bargaining

a: difference rule (3.1) *b: level rule (3.2)*

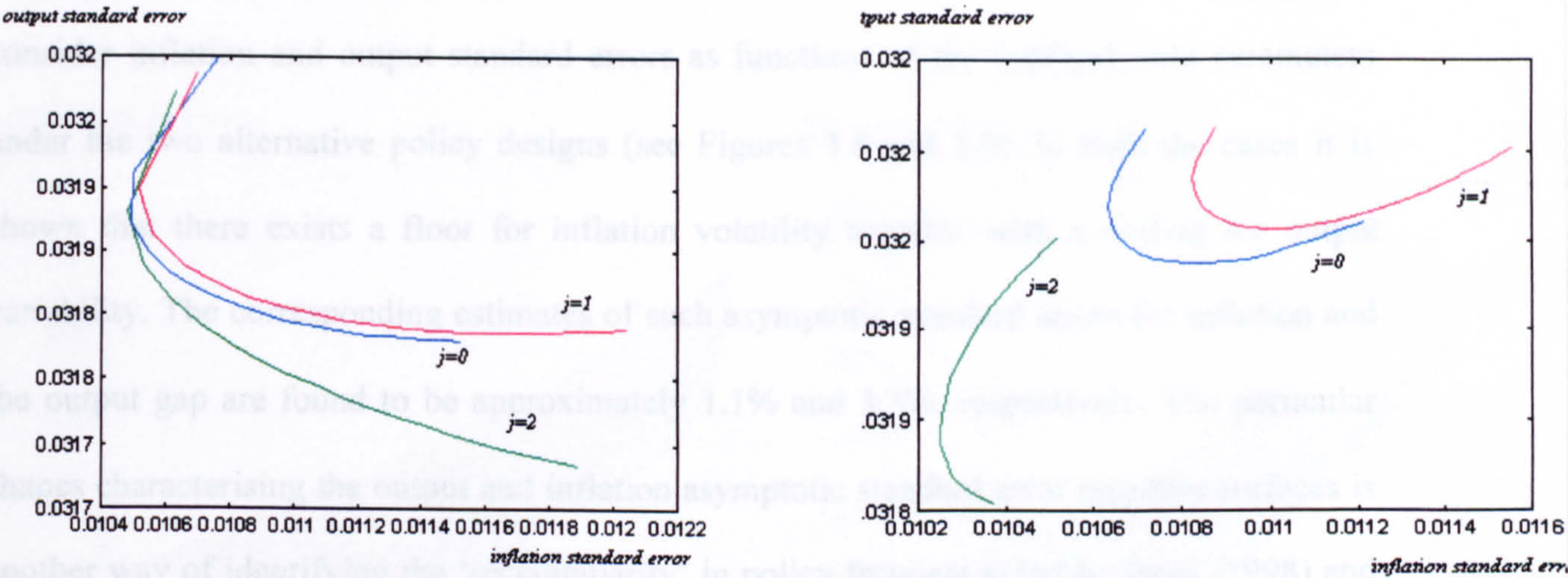


Figure 3.6 Inflation-output standard error trade-offs under 1-quarter forward-looking wage bargaining

a: difference rule (3.1) *b: level rule (3.2)*

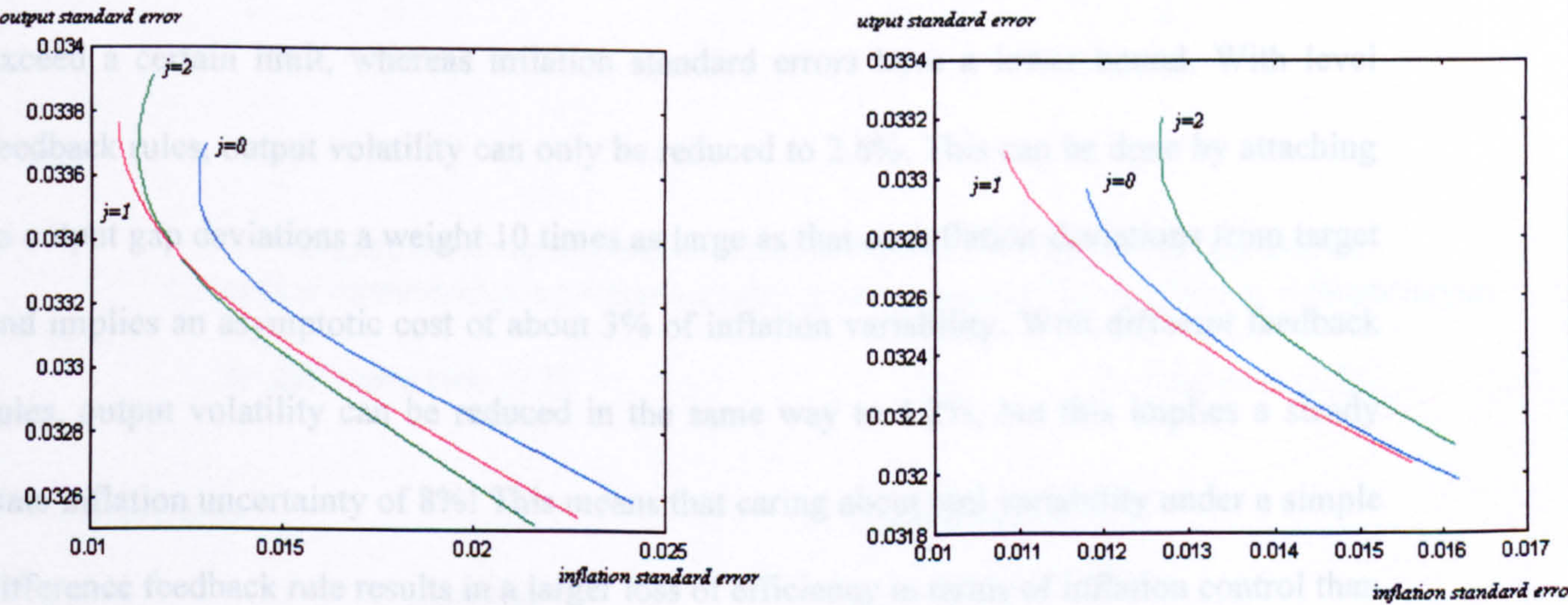
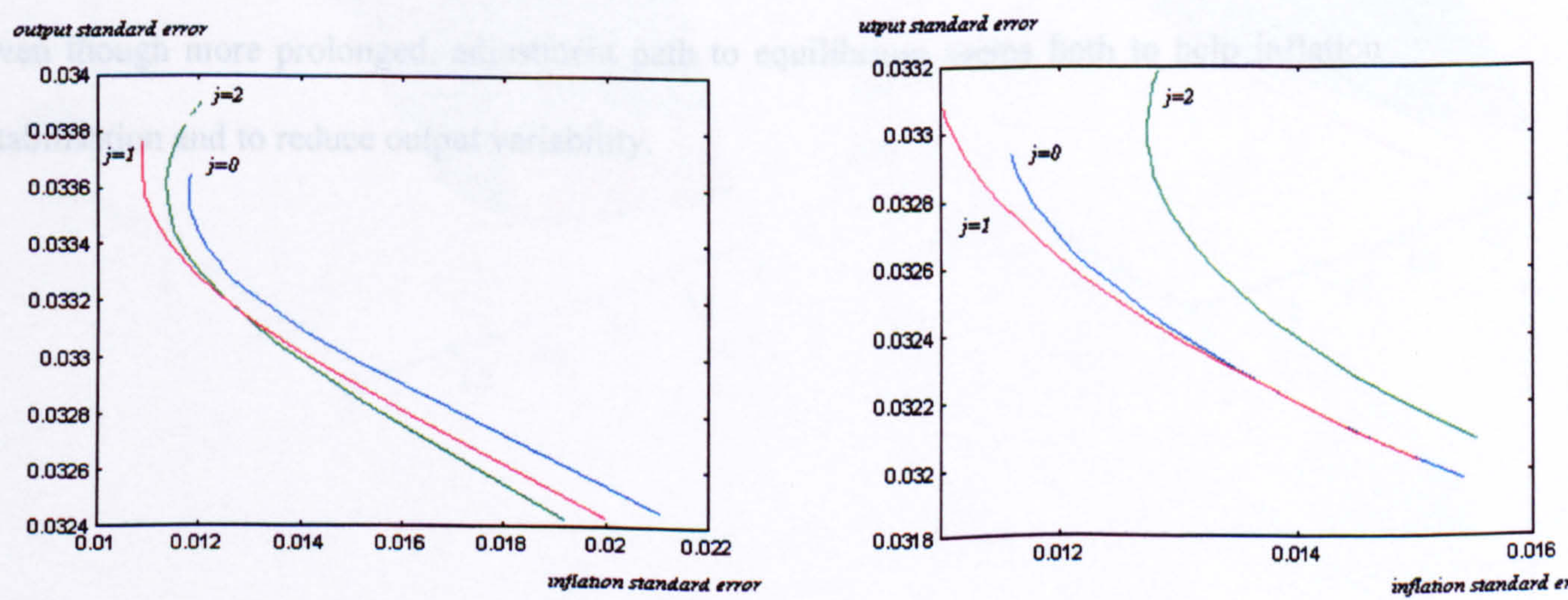


Figure 3.7 Inflation-output standard error trade-offs under 2-quarter forward-looking wage bargaining

a: difference rule (3.1) *b: level rule (3.2)*



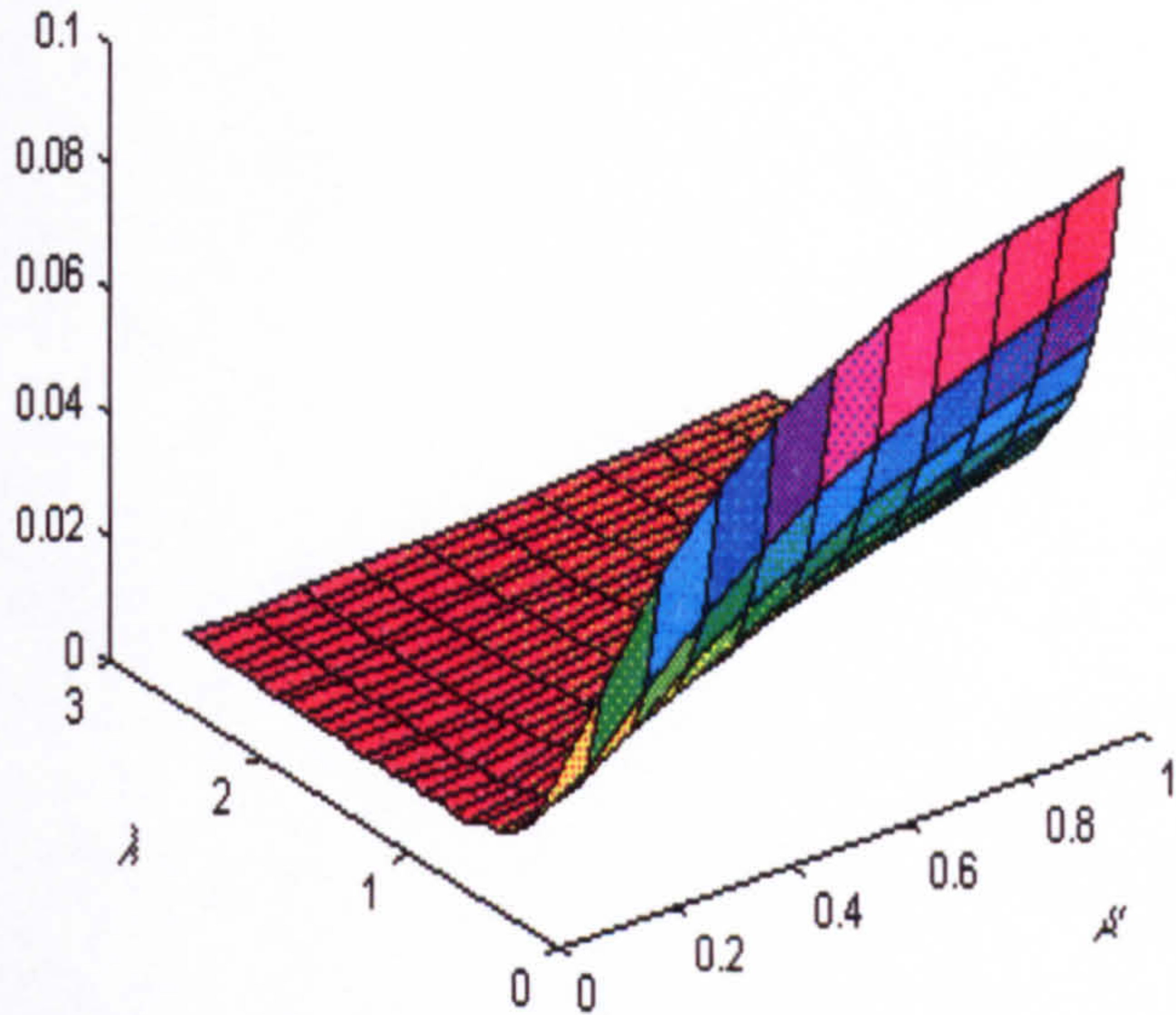
Sensitivity to λ and μ In the light of these results, the remaining comparisons focus on the most interesting wage bargaining/monetary policy specification; namely that in which both policymakers and private sector are one-quarter forward-looking. Within this set-up we next consider inflation and output standard errors as functions of the feedback rule parameters under the two alternative policy designs (see Figures 3.8 and 3.9). In both the cases it is shown that there exists a floor for inflation volatility together with a ceiling for output variability. The corresponding estimates of such asymptotic standard errors for inflation and the output gap are found to be approximately 1.1% and 3.3%, respectively. The particular shapes characterising the output and inflation asymptotic standard error response surfaces is another way of identifying the ‘rectangularity’ in policy frontiers noted by Bean (1998) and others. That is, in the context of assessing the relative weight to be placed on output versus inflation volatility, even in cases of extreme preferences, losses in output stability cannot exceed a certain limit, whereas inflation standard errors have a lower bound. With level feedback rules, output volatility can only be reduced to 2.6%. This can be done by attaching to output gap deviations a weight 10 times as large as that on inflation deviations from target and implies an asymptotic cost of about 3% of inflation variability. With different feedback rules, output volatility can be reduced in the same way to 1.2%, but this implies a steady state inflation uncertainty of 8%! This means that caring about real variability under a simple difference feedback rule results in a larger loss of efficiency in terms of inflation control than under a level feedback rule. This seems to be explained, once again, by the overshooting and aggressive responses to exogenous shocks that characterise difference rules. A smoother, even though more prolonged, adjustment path to equilibrium seems both to help inflation stabilisation and to reduce output variability.

Figure 3.8 Inflation standard errors as a function of target rule parameters
(1-quarter forward-looking wage bargaining and 1-quarter ahead inflation-forecast target)

A: difference rule (3.1)

b: level rule (3.2)

inflation standard error



inflation standard error

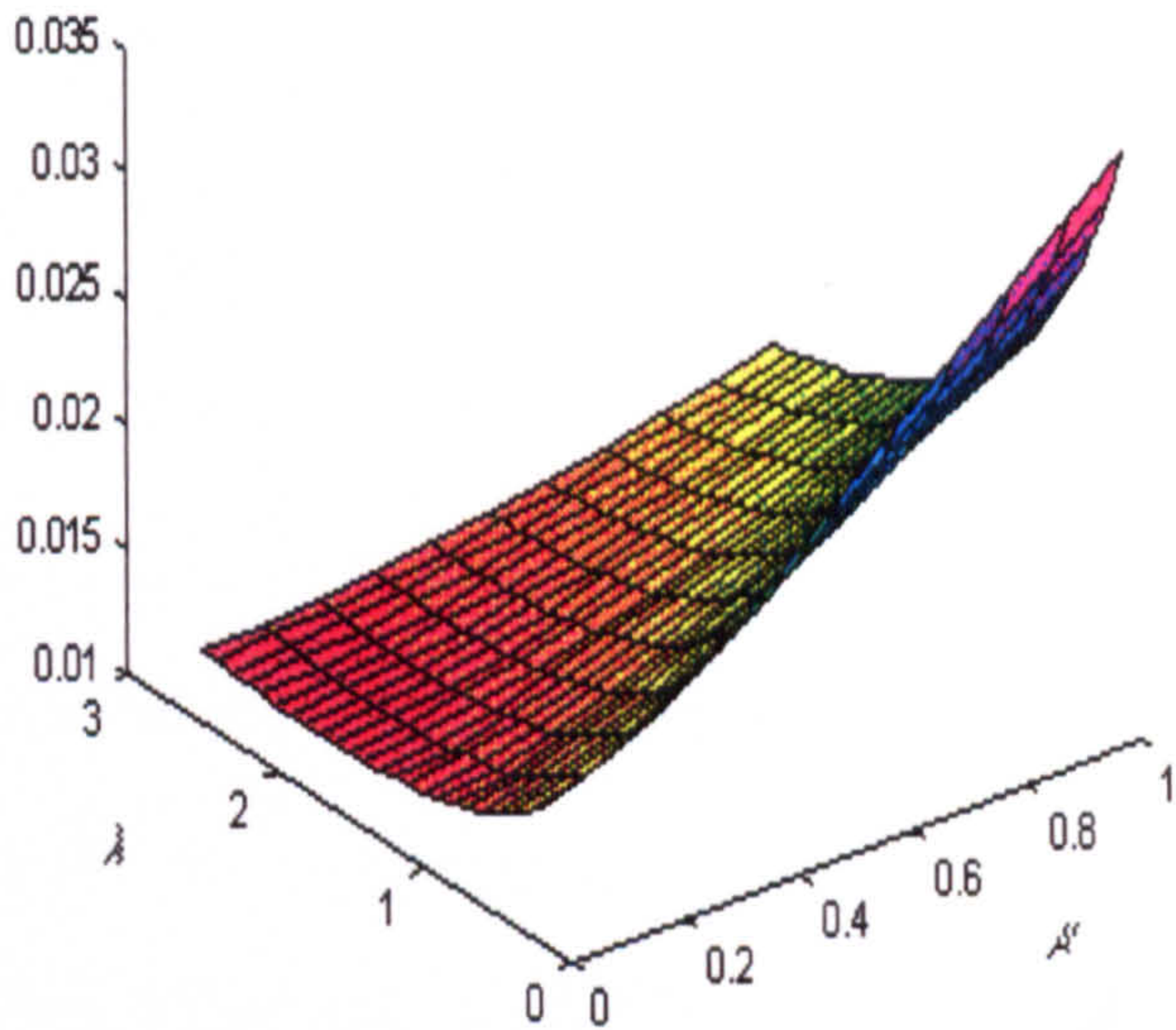
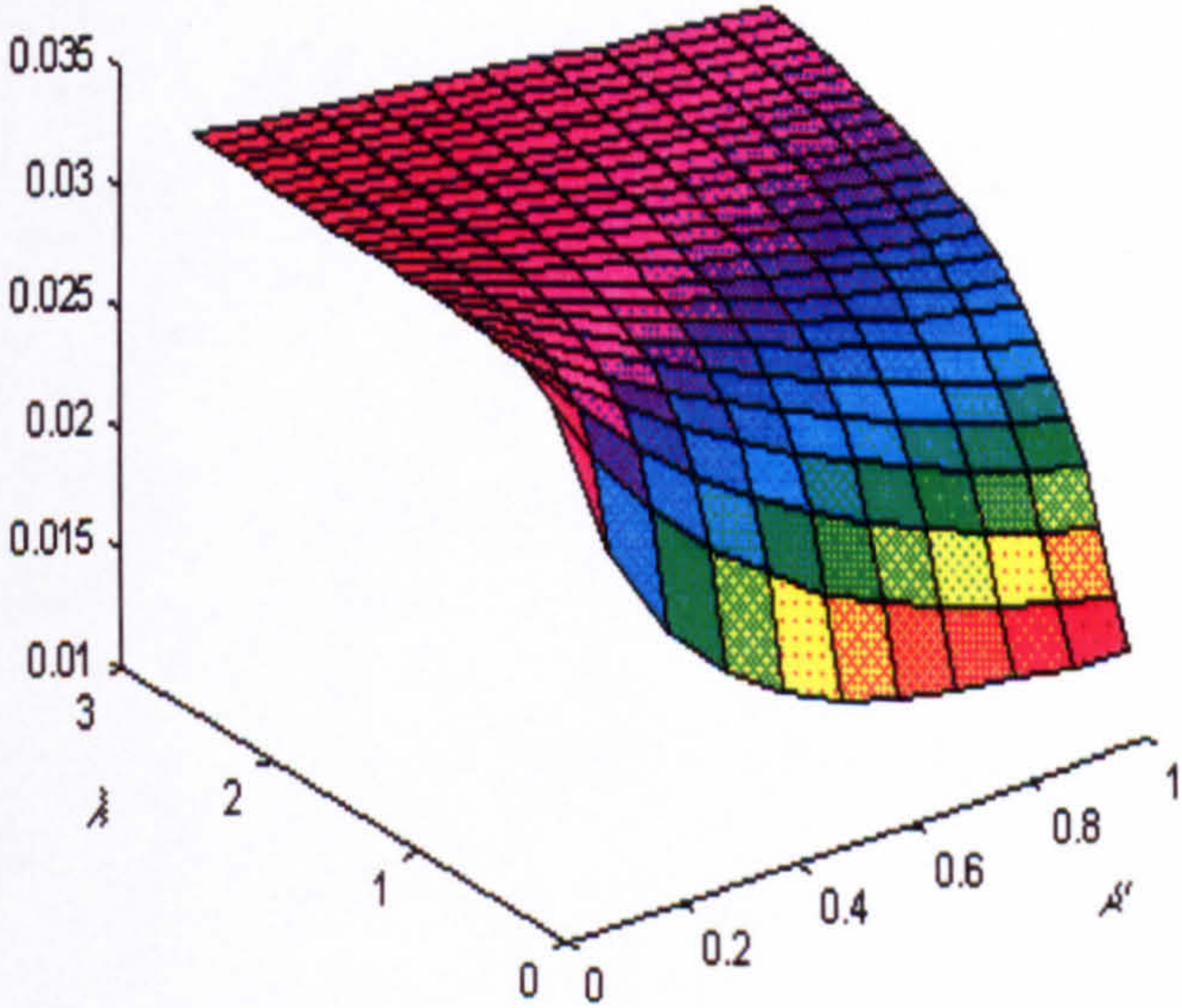


Figure 3.9 Output standard errors as a function of target rule parameters
(1-quarter forward-looking wage bargaining and 1-quarter ahead inflation-forecast target)

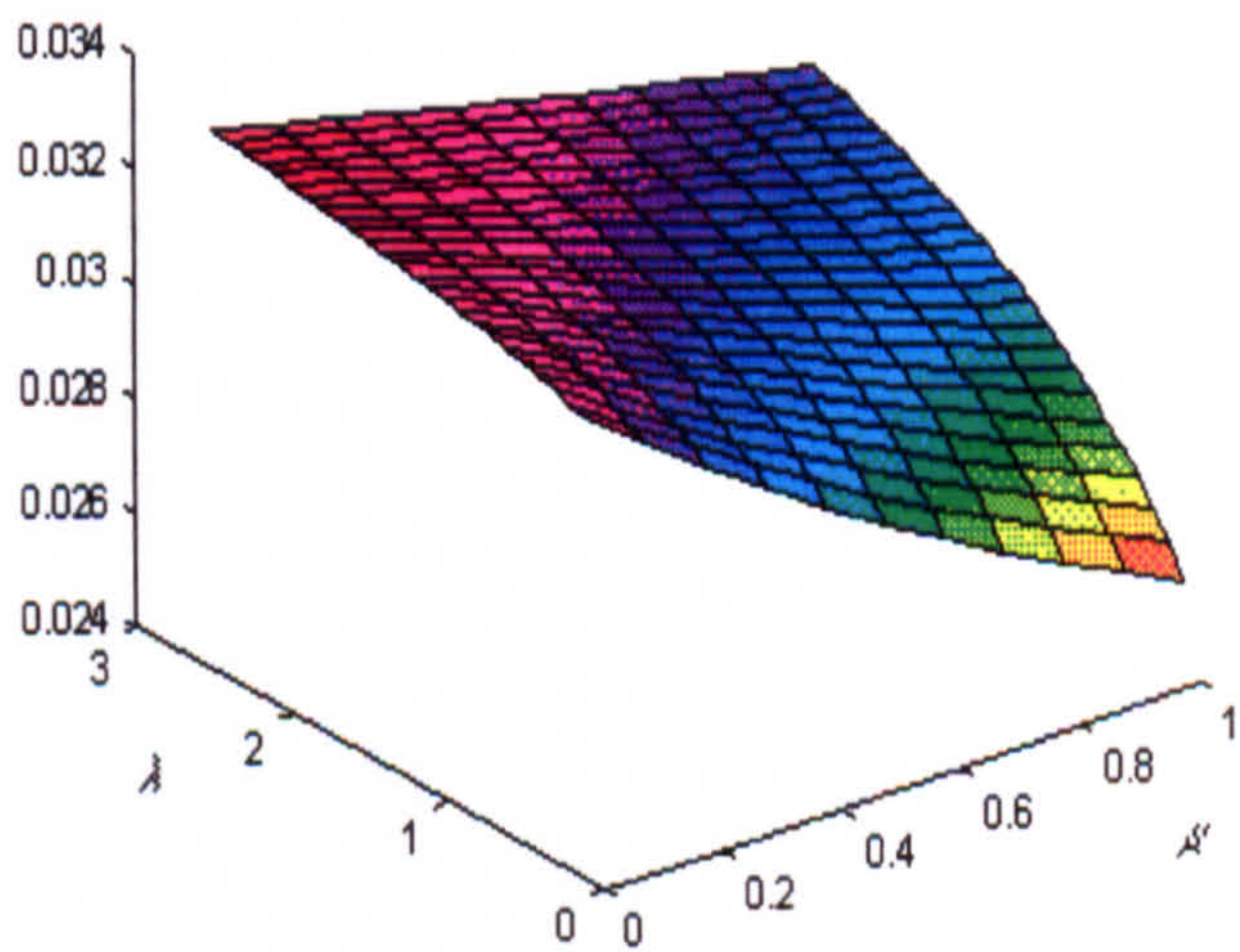
A: difference rule (3.1)

b: level rule (3.2)

output standard error



output standard error



Output-inflation trade-offs In Figures 3.10 and 3.11 maps of standard error trade-offs are juxtaposed. Whereas in Figure 3.10 each trade-off is constructed by varying λ (0.1 - 2.5) for a given value of μ , in Figure 3.11 we keep λ fixed and vary μ (0.0 - 1.0) along each trade-off. Again, the relevant model specification assumes one-quarter forward-looking labour market and one-quarter-ahead forecast inflation target. In general both inflation and output standard errors vary within a smaller range of values under level rules (3.2). Moreover, Figure 3.10 shows that, as μ increases, some reductions in output variability can be achieved with either rule. However, in order to keep inflation uncertainty at a reasonable level, λ has to be increased accordingly, thereby moving towards the left end of the locus. This implies that, if a target of such a form is publicly announced, then stronger signals of inflation control have also to be sent to the market in order to make it effective. Nonetheless, the kink that appears at the upper left end of any trade-off confirms the existence of a lower bound for reductions in inflation variability: further tightening of the monetary policy cannot induce any better inflation control beyond such a point. Figure 3.11 shows that such a critical value for λ can be identified as 1.0: for greater values of λ , the corresponding inflation-output trade-offs are further away from the origin. Furthermore, output variability remains in the range 3.0-3.3% as λ is increased beyond 1, irrespective of the weight μ on output deviations. With difference rules, the trade-offs appear to be indistinguishable from one another as soon as λ reaches 0.5.

Figure 3.10 Map of inflation-output standard error trade-offs under fixed μ and varying λ (1-quarter forward-looking wage bargaining and 1-quarter ahead inflation-forecast target)

A: difference rule (3.1)

b: level rule (3.2)

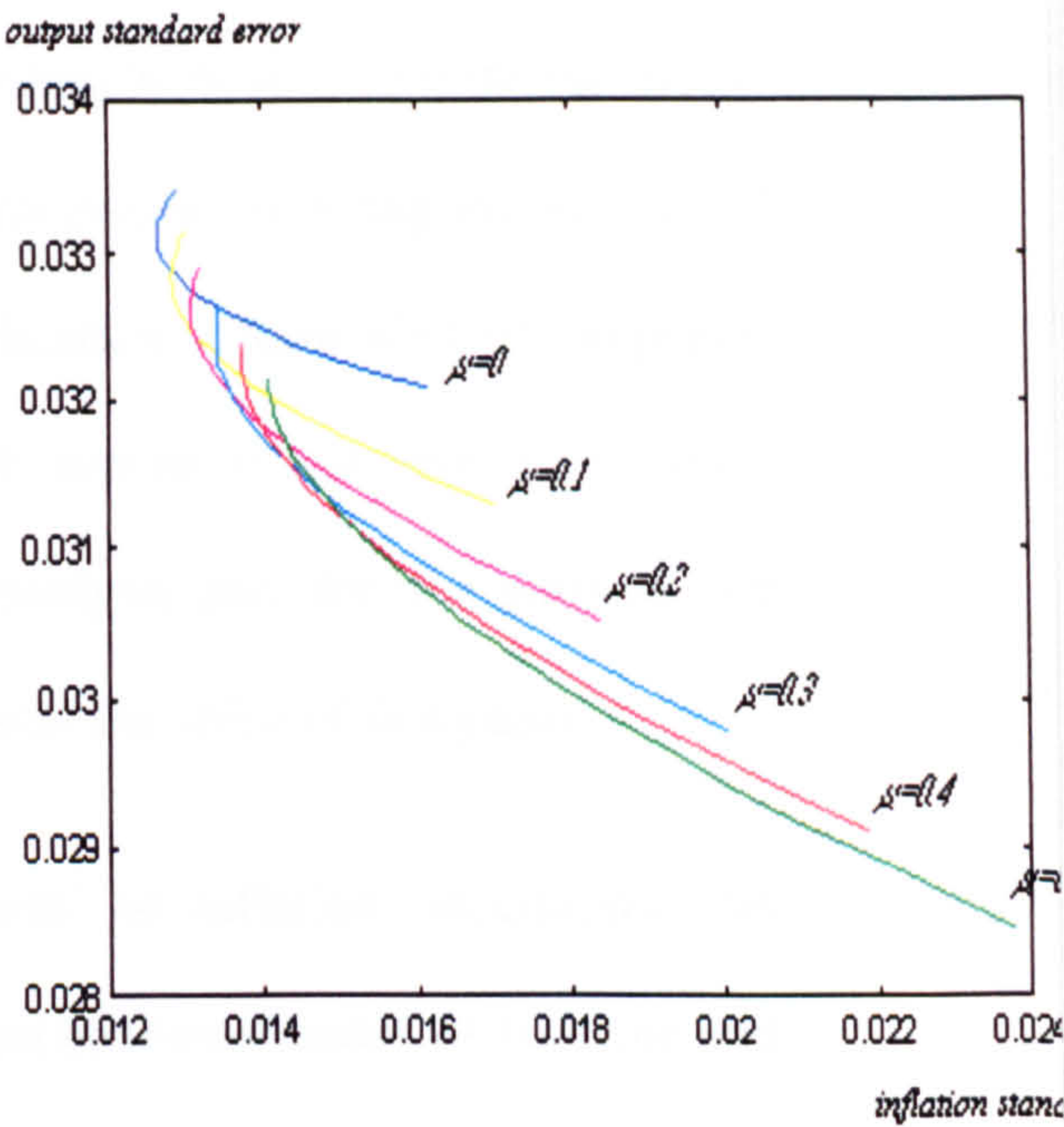
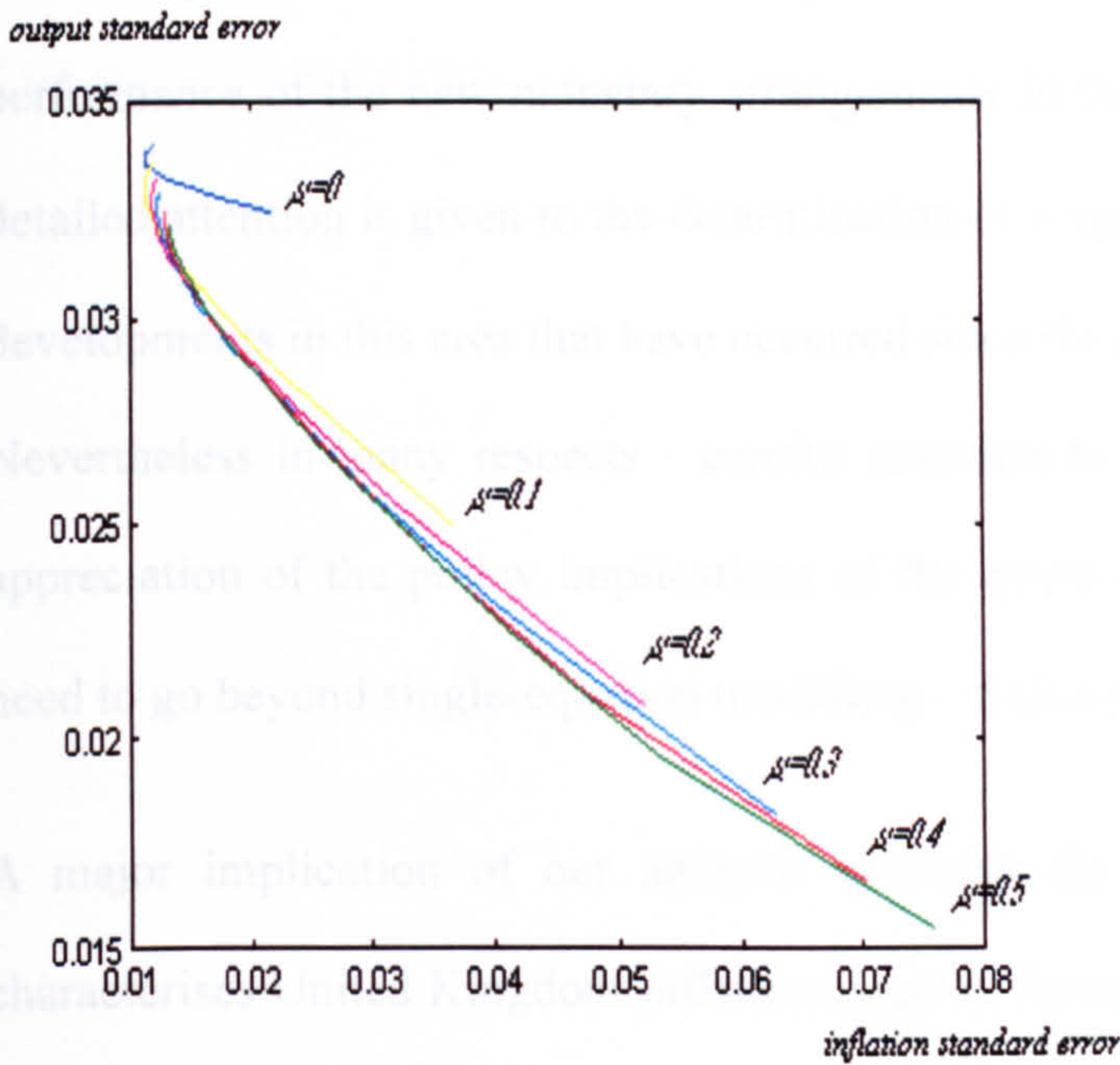
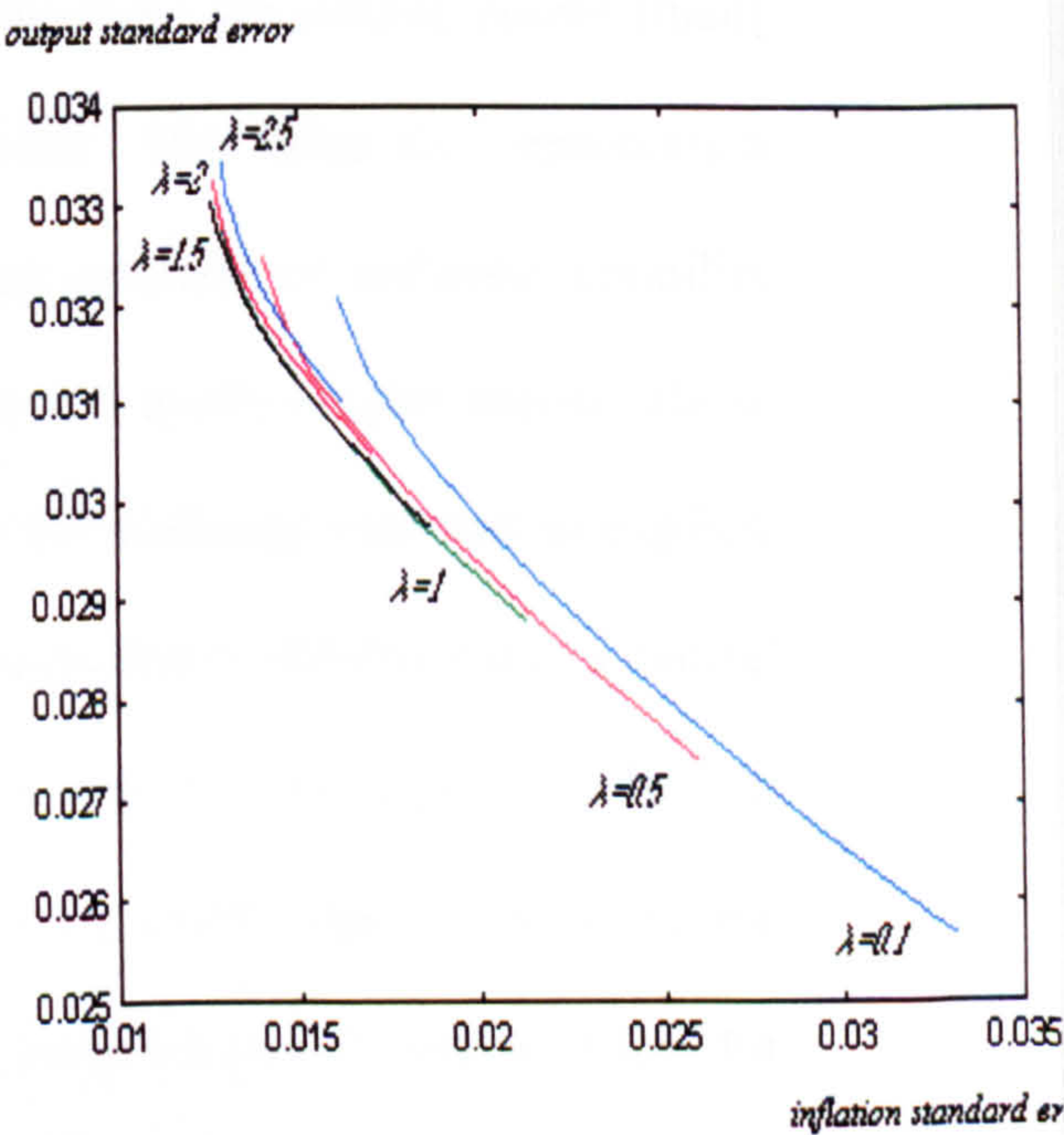
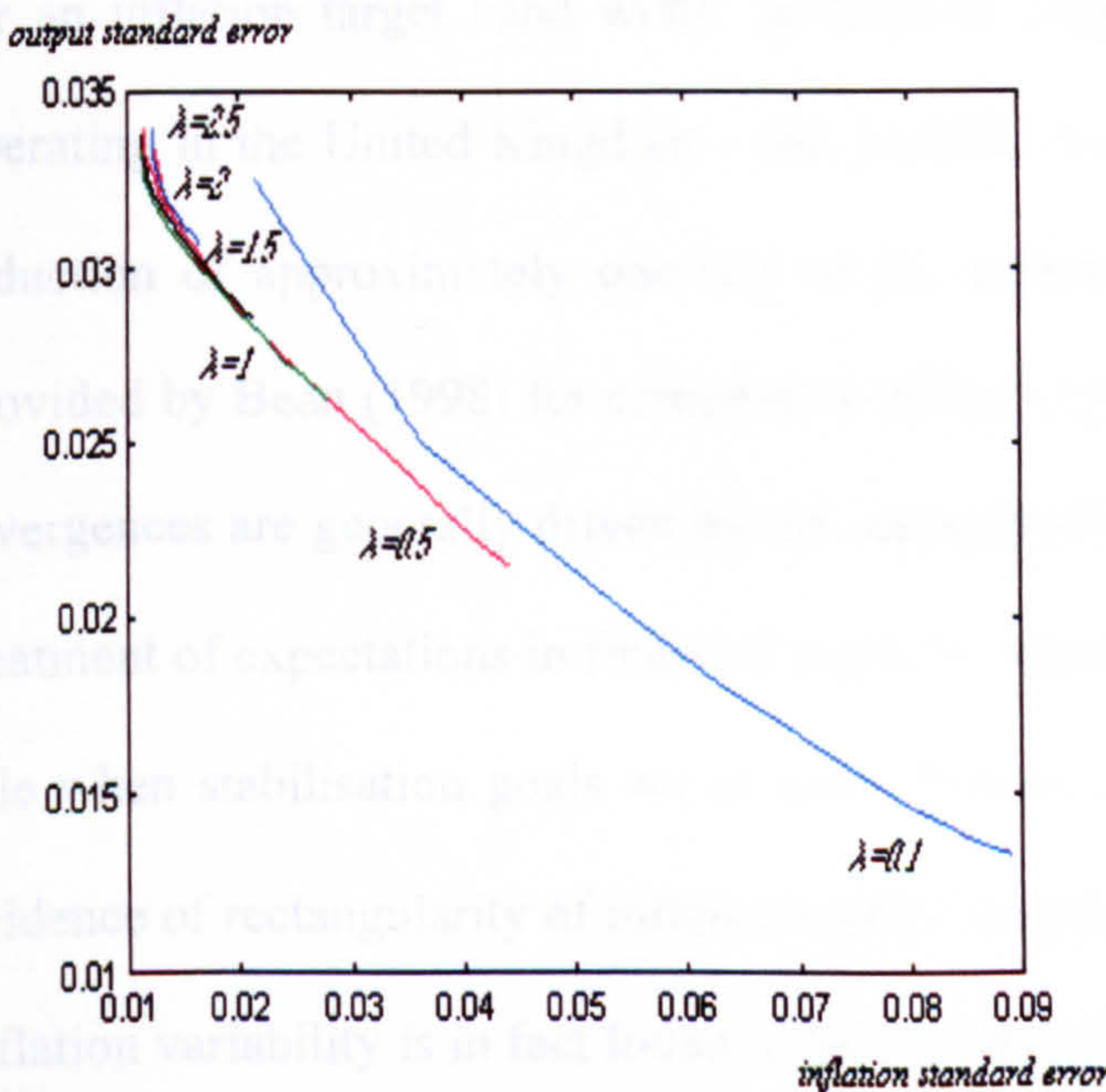


Figure 3.11 Map of inflation-output standard error trade-offs under fixed λ and varying μ (1-quarter forward-looking wage bargaining and 1-quarter ahead inflation-forecast target)

A: difference rule (3.1)

b: level rule (3.2)



3.4 CONCLUSIONS

This chapter uses a small data-congruent rational expectations model to assess the performance of the new monetary arrangements in the United Kingdom. Within the model detailed attention is given to the determination of wages and prices, reflecting the substantial developments in this area that have occurred since the publication of Sargan's Colston paper. Nevertheless in many respects - careful attention to both statistical and economic issues, appreciation of the policy implications of the empirical analysis and, for this purpose, the need to go beyond single-equation modelling - it also respects the spirit of that paper.

A major implication of our analysis concerns the 'lump' of inflation uncertainty that characterises United Kingdom inflation targetry. In contrast to the estimates of Haldane and Salmon (1995) of a standard error of annual inflation in the range 3 to 4½ percentage points, the results presented above cover a much lower range of values. Our 'optimal' value of about 1% inflation standard error implies that a tolerance interval of plus or minus one percentage point can be achieved approximately two-thirds of the time, compared with their argument for an inflation target band width 'at least as large as the three percentage points [then] operating in the United Kingdom - and possibly much wider'. This value also represents a reduction of approximately one-half of the corresponding estimate of inflation volatility provided by Bean (1998) for comparable policy objectives in a much simpler model. These divergences are generally driven by the endogenisation of the exchange rate and an explicit treatment of expectations in financial markets, which suggests that credibility plays a central role when stabilisation goals are at issue. However, our results provide support to Bean's evidence of rectangularity of inflation-output standard error trade-offs. The lowest bound for inflation variability is in fact found to be coupled, over the relevant period, with a ceiling for output volatility. This means that beyond a certain point, further tightening of the monetary policy cannot induce any better inflation control. At the same time, if some weight is to be

placed on output variability, then stronger signals of inflation control have also to be sent to the market, to make an inflation target monetary policy effective. Finally, we argue that forward-lookingness in labour and foreign markets is likely to have a crucial impact on the effectiveness of monetary policy, whereas the choice of which inflation targeting horizon does not seem to make much difference.

APPENDIX

<i>EENIC</i>	Employees' contributions of NICs (£M)
<i>EMF</i>	Employment in UK manufacturing ('000s)
<i>EMPNIC</i>	Employers' payments of NICs (£M)
<i>ENMF</i>	Employment in UK non-manufacturing ('000s)
<i>ERPR</i>	Average earnings per employee, private sector (£)
<i>MCOST</i>	Index of manufacturers' costs (1990 = 100)
<i>NIS</i>	NI supplementary contributions (£M)
<i>OCR</i>	Employers' other contributions (£M)
<i>PMBM</i>	AVI for imports of basic materials
<i>PCE</i>	Consumers' expenditure deflator (1990 = 100)
<i>PPGDP</i>	Deflator for average measure of GDP at factor cost (1990 = 100)
<i>PRODS</i>	Private sector productivity: $\frac{(YPROM + 278.29 \cdot YMF)}{(EMF + ENMF)}$
<i>Q</i>	Sterling effective <i>real</i> exchange rate: $(RX \cdot WPXM) / PPGDP$
<i>RETRA</i>	Retention ratio: $1 - (TYEM + 0.914 EENIC) / WFP$
<i>ROSHT</i>	Trade weighted three month major 7 (excl. UK) interest rate (UK effective exchange rate weights)
<i>RS</i>	UK three month inter-bank rate (% p.a.)
<i>RX</i>	Sterling effective exchange rate (1990 = 100)
<i>SD</i>	Standard deviation of annual inflation (percentage points): $SD = 100 * \left[\frac{PPGDP}{L^4 (PPGDP)} - 1/5 L (1+L+L^2+L^3+L^4) \frac{PPGDP}{L^4 (PPGDP)} \right]$
<i>SVPPDGP</i>	Variance of annual inflation defined as a moving average over the last 5 quarters of inflation squared deviations: $SVPPDGP = 1/5 L (SD^2 + L(SD^2) + L^2(SD^2) + L^3(SD^2) + L^4(SD^2))$
<i>TE</i>	Employers' tax rate: $\frac{(EMPNIC + NIS + OCR)}{WFP}$
<i>TYEM</i>	Accruals of tax on employment income (£M)
<i>U</i>	Seasonally adjusted UK unemployment consistent with current coverage ('000s)
<i>UDEN</i>	Union density (constant from 1980q4)
<i>WEDGE</i>	Tax wedge: $(TE) \cdot (1 - RETRA) \cdot (PCE / PPGDP)$
<i>WFP</i>	Wage and salary bill (incl. forces' pay) (£M)
<i>WPXM</i>	OECD manufacturers' export prices, \$
<i>YMF</i>	Manufacturing output index adjusted for stock changes (1990 = 100)
<i>YMF*</i>	Potential manufacturing output, expressed by the fitted values of a regression of <i>YMF</i> on a constant and a trend
<i>YPROM</i>	Output in the private non-oil, non-manufacturing and public traded sectors at constant factor cost (£M, 1990).

Part Two

A Large-Scale Country Model

Chapter Four

Monetary Transmission Channels, Monetary Regimes and Consumption Behaviour

4.1 INTRODUCTION

During recent years, academic researchers and policy-makers have paid an increasing amount of attention to the process of globalisation and harmonisation of financial structures, especially with regard to EMU (among many others, Borio, 1997; Buttiglione and Ferri, 1994; Cecchetti, 1995; Dale and Haldane, 1995; De Bondt, 2000). Since January 1999, eleven EU members have locked their currencies together, with the European Central Bank officially in charge of the short-term interest rate policy. This has certainly raised an interest, at the macroeconomic level, in assessing whether a common monetary policy will have a different impact in different economies. There have been several attempts to shed light on this issue, but findings have been contradictory. On the one hand, vector autoregression analyses tend to

show little differences in the policy transmission mechanisms among European countries (see Gerlach and Smets, 1995; Britton and Whitley, 1997; Dornbusch *et al.*, 1998 as an exception). Such evidence has made many economists sceptical of the view that noticeable cross-country differences exist in the speed, intensity and compass of the transmission of monetary policy impulses to economic activity. On the other hand, a study of the Bank of International Settlements (1995) based on central banks' large-scale macroeconomic models linked to the Fed's global model arrives at opposite conclusions. It suggests, for instance, that the UK has an exceptionally large sensitivity of output to interest-rate movements, in contrast to other continental European countries. A recent paper by Maclennan *et al.* (1998) assesses in detail the conflicting empirical evidence on the issue, and argues that there are 'enormous differences in housing and financial market institutions' across EU states. These are likely to have profound effects on the responsiveness of output and prices across countries to (common) policy interest rate movements.

This chapter takes stock of current debate and aims to analyse the characteristics of the UK monetary transmission mechanism by undertaking simulation exercises on the January 1999 version of the National Institute's Domestic Econometric Model (NiDEM). In view of the UK's decision not to enter EMU at its commencement, there is an interest in assessing whether monetary policy would exert an analogous influence on the real economy under the current monetary arrangements and a fixed exchange rate. This is not, however, our unique goal. In this chapter, we also intend to disentangle the total change in real output into the individual contributions from several transmission channels. In particular, we aim to assess the repercussion effects of monetary impulses on spending components through their impact on fiscal variables. Given the decentralisation of fiscal policy and fiscal structures within EMU, evidence of a quantitatively important fiscal channel of monetary policy would weaken the argument for a broadly similar response of the EU economies to a common change in the policy rate.

Furthermore, a large body of the literature has recently returned to the classical empirical question ‘What are the real effects of monetary policy?’, by analysing both the relation between money and income and the role of financial intermediation and asset prices. Most policy-makers and economists now agree that monetary policy can significantly affect real economic activity, at least in the short run. Considerable debate remains, however, about how exactly monetary policy affects the economy (see below). In this respect, we are here interested in filling the gap between the traditional perspective, according to which monetary policy exerts its effects on spending components through its direct influence on the cost of capital (Taylor, 1995), and the more recent ‘credit view’, which argues that other ‘accelerator’ variables, such as cash flow, have the greatest impact on spending (Bernanke and Gertler, 1995). To do this, we focus on consumers’ expenditure and, in the light of the recent literature on life-cycle consumption, we re-estimate the corresponding equation in NiDEM. The inclusion of permanent human capital, as well as the explicit modelling of Ricardian non-neutralities, is likely to account for a weaker interest rate sensitivity of consumption and a higher sensitivity of consumption to changes in current disposable income and fiscal policy.

The structure of the chapter is as follows. Section 4.2 provides an overview of the main types of monetary transmission channels that can be found in the literature on private consumption. In this respect, we explicitly consider two alternative approaches to the modelling of aggregate consumers’ expenditure: firstly, the ‘disposable funds’ approach suggested by Pain and Westaway (1994) and currently employed in NiDEM, and secondly, a modified version of the Darby and Ireland’s (1994) life-cycle consumption equation. The latter is currently implemented in COMPACT, a relatively small model of the UK economy with transparent theoretical foundations, developed at the University of Exeter by a group of modellers led by Simon Wren-Lewis. Section 4.3 summarises the main properties of the model we use, NiDEM¹. We proceed by simulating the effects of a temporary, 50 basis point, reduction in the policy rate under both endogenous and exogenous nominal exchange rates, using both

specifications for aggregate consumers' expenditure specified above. The simulation results are presented in section 4.4. Here, the sensitivity of the UK monetary transmission mechanism to different policy regimes as well as the implications of employing alternative models of consumers' expenditure are finally quantified. By virtue of the methodology adopted, not only the total impact of the temporary monetary shock on the main GDP components is evaluated, but the contribution of the various transmission channels to such an impact is also measured. Section 4.5 concludes the chapter.

¹ An comparison of the properties of the these two leading macromodels of the UK economy is provided in Church *et al.* (2000) under standardised simulation exercises.

4.2 TRANSMISSION MECHANISMS AND CONSUMPTION MODELS

4.2.1 Monetary transmission channels

Private consumption is undoubtedly the single most important component of national income. In 1998, for example, consumers' expenditure accounted for some 65 per cent of UK total GDP. For this reason, there is an interest in understanding how, and possibly how much, shocks to policy-determined interest rates affect consumption and, thereby, total GDP. In this respect, research results are not unambiguous. On the one hand, theory and empirical evidence seem to suggest that interest rates changes affect consumers' spending both directly and indirectly (see, for instance, Muellbauer and Murphy, 1993, 1997, for a focus on income expectations and housing market; Borio, 1997, for an appraisal of the credit channel; Church *et al.*, 1994, for a survey on UK large-scale macroeconomic models; MacLennan *et al.*, 1998, for a comprehensive discussion of the general issue); on the other hand, the puzzle of consumption's interest rate sensitivity looks still far from being resolved (Deaton, 1992; Muellbauer and Lattimore, 1995, and the symposium on the monetary transmission mechanism in the *Journal of Economic Perspective*, 1995). Below, we briefly describe the main channels through which policy-determined movements in the short-term interest rate are thought to affect consumption (for an extensive review of the theoretical literature on consumption see Muellbauer, 1994).

The *direct channel* captures the intertemporal substitution effect of a change in interest rates on private consumption. Empirically, the real interest rate effect on consumption is likely to be unstable and may even have an indeterminate sign. To explain this, let us consider a simple two-period consumption-choice problem. Most consumption literature assumes intertemporally additive preferences, which accordingly imply life-time utility, U , to be the sum of the sub-utilities of consumption in each period, discounted by a subjective discount rate, δ . Namely:

$$U = u(c_1) + \frac{1}{1+\delta} u(c_2). \quad (4.1)$$

A further assumption of homothetic preferences (allowing the ratios of consumption in different periods to be independent of income or wealth given a linear intertemporal budget constraint) lets the utility function exhibit a constant elasticity of substitution. Under this hypothesis

$$U^\rho = C_1^{-\rho} + \frac{1}{1+\delta} C_2^{-\rho}, \quad (4.2)$$

where the elasticity of substitution, $\sigma = \frac{1}{1+\rho}$, measures the responsiveness of the consumption ratio to relative prices in the two periods, i.e. to $\frac{1}{1+r}$.

The intertemporal maximisation of the life-time utility function (4.2) given a life-cycle linear budget constraint expressed in real terms, i.e.

$$C_1 + \frac{1}{1+r} C_2 = A_0(1+R) + Y_1 + \frac{1}{1+r} Y_2^E, \quad (4.3)$$

allows derivation of the following Euler consumption equation:

$$C_1^{-1/\sigma} = \frac{1+r}{1+\delta} C_2^{-1/\sigma}. \quad (4.4)$$

This is a first-order condition stating that marginal utility is equal to the next period's marginal utility weighted by the ratio of the market and subjective discount rates. Taking the logarithm of the Euler equation (4.4) shows that, in this case, the planned log-change in consumption is approximately equal to $\sigma(r - \delta)$. Thus, the greater the elasticity of substitution, the greater the increase in current consumption required to substitute into lower future consumption when the real interest rate falls.

However, there are good reasons to believe that the extent of intertemporal substitutability is low, that is consumers prefer consumption patterns to be steady over time. Taking this hypothesis to an extreme level, let us consider the special case where the elasticity of substitution is zero. If, in addition, future non-property income is expected to be unchanged from present levels, a reduction in the real interest rate r is likely to *reduce* current consumption, as effectively, initial assets will yield lower returns and consumption will fall when the real rate of return is lowered. This is illustrated by the solution for the consumption function which is obtained when the $-\sigma$ power of the Euler equation (4.4) is combined with the life-cycle budget constraint (4.3). This gives

$$C_1 = \frac{1}{[1 + (\frac{1}{1+\delta})^\sigma (\frac{1}{1+r})^{1-\sigma}]} [A_0 (1+R) + Y_1 + \frac{1}{1+r} Y_2^e], \quad (4.5)$$

which reduces to

$$C_1 = \frac{1}{[1 + (\frac{1}{1+r})]} [A_0 (1+R) + Y_1] \quad (4.6)$$

in the special case where there is a zero elasticity of substitution and static real income expectations. It is clear, therefore, that the higher the assets-to-income ratio, the less likely it is that a negative interest rate effect will result, *ceteris paribus*. The overall effect is ambiguous if, with positive assets, the elasticity of substitution is below unity, but the effect is more likely to be negative the higher the elasticity. Since the ratio of assets to income varies over time and most empirical evidence agrees that the elasticity is 0.5 or less, a relatively small and unstable intertemporal substitution effect is to be expected.

The *income channel* represents the impact interest rate changes have on flows of interest and dividend payments between sectors. Within a simple life-cycle framework, consumers attempt to keep planned consumption constant. However, empirically, consumption follows income rather more closely over the life cycle than theory predicts. Uncertainty about future income

and future needs provides part of the explanation. If future income is more heavily discounted due to uncertainty, current income must necessarily play a larger part in determining current consumption. This is particularly true for the young who have no buffer of assets. Similarly, the retired do not dissave on the scale predicted by simple life-cycle theory. The uncertainty surrounding consumption needs is indeed likely to be particularly acute for the elderly, as health in later life is more fragile. Credit constraints are another reason why consumption in many empirical studies follows the hump-shaped profile of life-cycle income more closely than theory suggests. Inasmuch as households are unable to borrow against their future income, their consumption decisions are essentially driven by cash-flow variations. In practice, consumption is equal to current income for the majority of credit-constrained households. Consumers are more likely to encounter credit constraints whenever their initial income and asset levels are low relative to expected income, and this is generally the case for the young.

The opposite is true when financial deregulation occurs. As was the case in the UK during the 1980s, credit becomes more easily available following a period of financial liberalisation. While the share of credit-constrained households falls, the debt-to-income ratios rises. The amount of gearing significantly increases in the economy and the spendability of illiquid assets is boosted. In these circumstances, the *credit channel* becomes accordingly more important within the transmission mechanism of monetary policy. Thus, the effect of a change in the short-term interest rates on households' debt burden may help explain the strong stimulus to housing demand, despite the presumably weak link between monetary policy and real long-term rates. This correlation becomes even stronger when, as is the case in the UK, most mortgage debt is subject to variable interest rates and therefore highly sensitive to short-term interest rate movements. The *wealth channel* represents the impact interest rate changes have on expenditure via house price and financial asset responses, and, hence, the value of households' wealth. Consumers typically hold a balance of liquid assets which can easily be converted into expenditure when required, and illiquid assets, that typically yield a higher rate

of return. Housing, which is the most important single asset for most households, has spending consequences which differ from those of other illiquid financial assets: it enters the utility function via housing services. As the relative price of any durable good has an effect on the consumption function of both durables and non-durables, expenditure for non-housing consumption will be affected by the price of housing. Life-cycle consumer theory therefore suggests that a rise in real house prices, following a reduction in the market interest rate, should have a positive wealth effect on non-housing consumption. At the same time, however, negative income and substitution effects on housing demand may occur, provided that the fall in interest rate is believed to be long-lived.

As the interest rate falls, prospective returns on other financial assets (such as equities and pension funds), also grow by means of increased expected growth, higher after-tax cash flow and the lower discounting of future returns. The interest sensitivity of consumption via the asset price channel is, in general, positively correlated with wealth-to-income ratios, although the perceived liquidity of the assets themselves should also be taken into account. A fall in interest rates is indeed likely to induce a portfolio switch towards more liquid assets and away from interest-bearing deposits or more expensive assets such as equities.

The asset price *par excellence* is the *exchange rate*. It is unambiguously recognised as the main channel through which interest rate changes have an impact on prices, particularly *via* its pass-through into import prices. Price competitiveness also affects domestic demand in a more direct way, that is by determining the proportion of consumers' expenditure leaking into imports. This is true also for a large economy such as the UK, given its relevant degree of openness.

Let us finally consider the less obvious, and generally ignored, transmission channel of monetary policy, the government *fiscal stance*. A fall in interest rates has a positive effect on expenditure by operating through the government's fiscal policy reaction function. There is a decline in the debt-service burden and an enlargement of the tax base following the cut in

interest rates. Both effects will engender tax cuts and have a positive impact on disposable income and, in turn, on consumption decisions.

In this work we explore the monetary transmission mechanism by considering the effect of a fall in the short-term interest rate on consumers' expenditure within a large-scale macroeconometric model, considering in turn two different approaches to the modelling of the consumption equation: a 'disposable funds' and a modified life-cycle approach. We believe consumption responses to interest rate changes are essentially determined by the theoretical assumptions built into the equation. This means, for instance, that the puzzle of consumption's interest rate sensitivity outlined above could be reformulated in terms of a debate on alternative theoretical frameworks. Evidence of a weak interest sensitivity of consumption within a life-cycle perspective would also provide empirical support for the neo-classical argument against deficit financing. Within a neo-classical growth model framework, embedding a life-cycle model of consumption behaviour allows deficit financing to significantly crowd out capital formation, thereby reducing the future stock of capital and thus increasing the real interest rate (Blanchard, 1985, Farukee *et al.*, 1997). If consumption is unresponsive to changes in real interest rates, then consumers hardly adjust their saving in response to budget relaxations, crowding out effects are, thereby, even more likely to emerge.

4.2.2 *The 'disposable funds' approach*

The default NiDEM consumption equation is based on a forward-looking dynamic optimisation in the presence of adjustment costs (see Westaway, 1993). The underlying idea is that consumers aim to achieve given steady-state consumption-to-income and total net wealth-to-income ratios (where total net wealth is given by net financial assets, W , plus housing assets, H). Accordingly, the sum of the coefficients on the non-property income term, NPY , and wealth term is equal to the sum of the coefficients on the CE terms, implying that the system has a long-run unit income elasticity in a steady state where wealth and income are

growing in line. There is a negative long-run effect from the nominal interest rate so that important inflation non-neutralities feature throughout. Finally, the model incorporates adjustment costs through a term in lagged consumption. The corresponding equation, as reported in the NiDEM manual, is given below².

$$\begin{aligned} \ln(CE)_t = & 0.359 \ln(CE)_{t+1} + 0.583 \ln(CE)_{t-1} + 0.005 \ln\left[\frac{100(W+H)}{CPI}\right], \\ & + 0.053 \left[\ln(NPY) + 0.75 \frac{100 \frac{MEW}{CPI}}{NPY} + \frac{100 \frac{CRED}{CPI}}{NPY} \right], \\ & - 0.005 (RREAL)_t - 0.0004537 INF_t - 0.217 \Delta U_{t-2} + 0.090 \Delta \ln(NPY)_{t-2} + dummies \end{aligned}$$

The equation captures the role of borrowing constraints, and the way in which they may change following financial deregulation, by modelling consumers' expenditure conditional on the flow of credit. For this reason, Pain and Westaway (1994) describe this specification as the 'disposable funds' approach. In this way, the modelling of consumption is separated into two parts, firstly the modelling of borrowing decisions and secondly the modelling of spending which is not credit financed. The equation suggests that 75 per cent of mortgage equity withdrawal (*MEW*) and all new consumer credit (*CRED*) is used to finance consumers' expenditure (*CE*). Net property income does not appear in the equation, as it affects consumption only through its effect on wealth. Dynamic effects from changes in unemployment (ΔU) are also included as a proxy for income uncertainty.

4.2.3 A modified 'life-cycle permanent-income' approach.

The alternative model of consumers' expenditure considered, determines consumption per head as a function of human and non-human wealth and the extent of borrowing constraints. It

² Since we intend to use this equation only for purposes of sensitivity analysis, it has not been re-estimated in this context. For *t*-ratios and diagnostic statistics the reader should then refer to the original study by Pain and Westaway (1994).

closely follows Darby and Ireland's (1994) consumption function, although it regards the balance between forward-looking and credit-constrained consumers (λ) as being constant over time. Estimation results, obtained using NiDEM's database, are presented below together with corresponding residual graphic analysis.

$$\begin{aligned} \left(\frac{CE}{POP}\right)_t &= \frac{(CE/POP)_{t+1} - \lambda(QRDNPY/POP)_{t+1}}{(PTREAL + 0.317 \cdot \lambda)_t} + \lambda \left(\frac{QRDNPY}{POP}\right)_t \\ &\quad (0.126) \\ &+ 0.045 \left\{ -\frac{\frac{100(W+H)}{CPI} + \lambda \frac{100 CRED}{CPI}}{(PTREAL + 0.317 \cdot \lambda)_t} \left(\frac{QRDNPY}{POP}\right)_t + \left[\frac{100(W+H)}{CPI} + \lambda \frac{100 CRED}{CPI}\right]_{t-1} \right\} \\ &\quad (0.021) \quad (0.126) \\ &\quad - 2.52 (1-\lambda) \Delta^2 U_t + 0.355 d864 \\ &\quad (0.50) \quad (0.149) \end{aligned}$$

Estimation Period: 1982:1 - 1998:4 (65 obs.)

Estimation Method: Non-linear GMM, MA(1), Bartlett weights
(Robust-White standard errors are given in brackets)

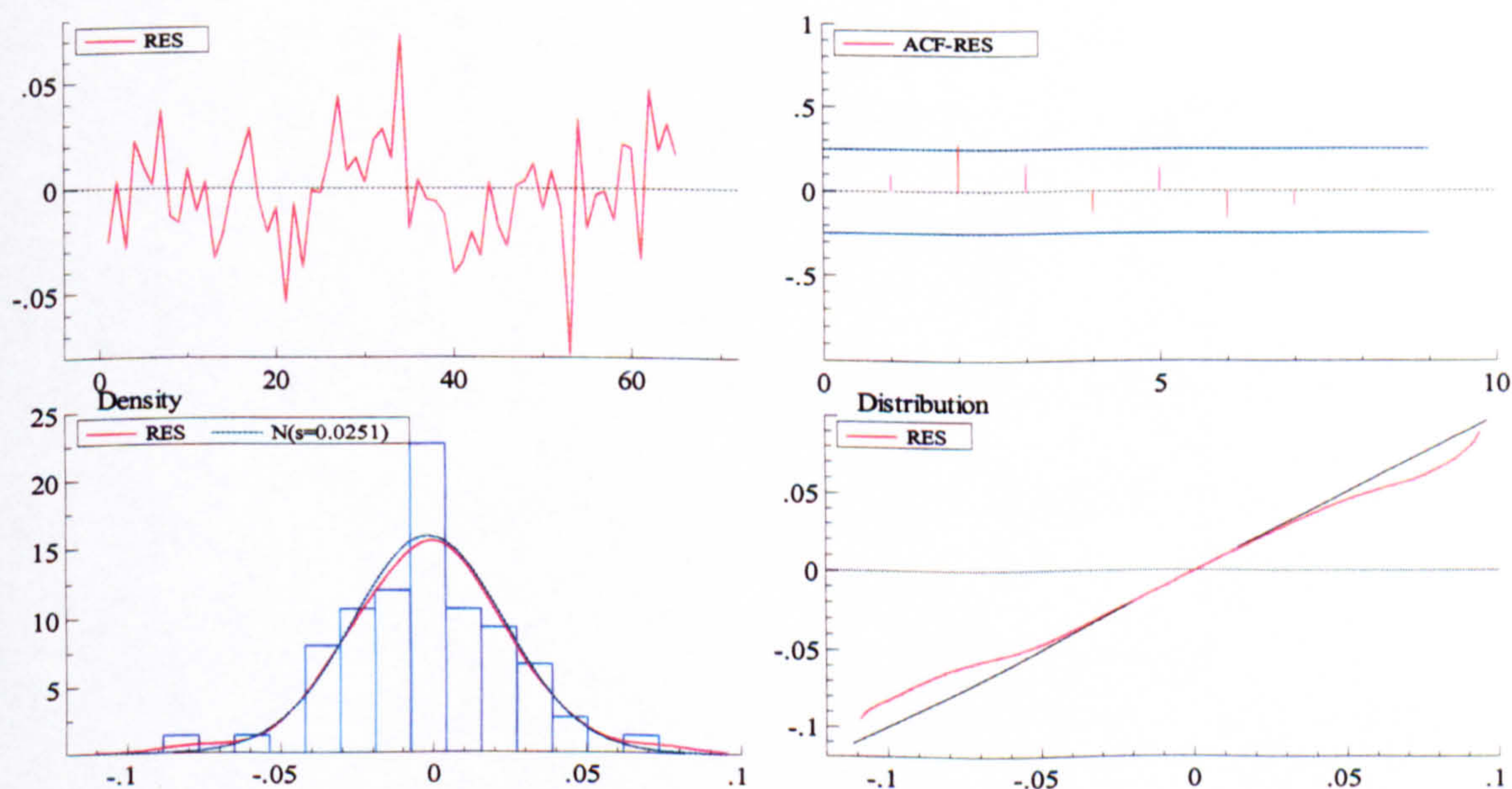
Instruments used: Second and third lags of each endogenous variable

Minimised Criterion Fct: 0.0933

Standard Error: 0.0253

Normality $\chi^2(2)$: 5.399 [0.067]

Test of overidentifying restrictions $\chi^2(6)$: 6.065 [0.416]



The theoretical basis for this alternative consumption model is taken from Blanchard's (1985) 'constant probability of death' model. The model is however modified such that consumption is determined by the decisions of both forward-looking and credit-constrained consumers. The former are assumed to smooth consumption over their lifetime, whereas the latter make their consumption choices on the basis of their current disposable income. For permanent-income consumers, consumption is proportional to a combination of non-human and human wealth. Non-human wealth is given by the sum of net financial assets, W , and housing assets, H . Human wealth³ is proxied by per-capita permanent non-property income, defined as a discounted sum of current and future non-property disposable income flows ($QRDNPY$). The discount factor applied is given by a fixed mark-up on the post-tax real interest rate ($PTREAL$), whose magnitude is estimated around 31.7%. The fact that consumers excessively discount the future by a constant factor can be explained both in terms of finite lifetime horizons and credit market imperfections. The wedge between the market and the subjective discount factor, however, has not been explicitly related to a time-varying measure of financial deregulation, as in the original Darby and Ireland's specification. Namely, given the sample period considered, we assume the implicit financial liberalisation index to maintain a constant value, that is its peak of 0.24. Because of such constancy assumption, the markup and the extent of credit constraints (λ) become two unidentifiable parameters in Darby and Ireland's model. Relying on their own estimates, we therefore impose a corresponding share of current income consumption (λ) equal to 0.161, while letting data determine the (fixed) markup on the market interest rate. Disposable-income consumers are instead assumed to spend all their current available income, namely $\lambda \left(\frac{QRDNPY}{POP} \right)_t$. Moreover, they are allocated a proportion λ of total consumer credit ($CRED$), thereby mimicking the common practice of credit limits being set as multiple of income. Finally and contrary to the original model

³ Following Darby and Ireland (1994) and in line with Hayashi (1982), the unobservable human wealth term is however eliminated from the model by quasi-differencing. Such a procedure gives rise to the MA(1) component in the residuals of the equation. To ensure asymptotic efficiency of the parameter estimates, the presence of an MA process requires the use of a GMM Hansen's (1982) estimation technique and twice lagged endogenous variables as valid instruments. Estimation was carried out using TSP software.

specification, unconstrained consumers are also assumed to be more responsive to income uncertainty (captured by the $\Delta^2 U$ term) than their counterparts who experience lower than average income growth⁴.

The behaviour of households is further described by other relationships determining, for instance, housing market fluctuations and wealth accumulation. These relationships are given by those incorporated within NiDEM, and will remain unchanged in the present study. It is therefore necessary to clarify the way in which monetary policy affects households' choices in NiDEM. Firstly, the stock of credit is negatively correlated with the interest payments-to-income ratio. This is consistent with the idea that gearing considerations are one of the major influences acting to constrain consumer borrowing, due to front-end loading of interest payments when inflation is high. Secondly, mortgage equity withdrawal grows in line with outstanding housing equity, while being influenced by financial liberalisation effects *via* a term representing the loan-to-value ratio for first-time buyers. Finally, as demand for housing is derived as an intertemporal Euler condition, and thereby conditioned on consumption, the same measures of human and non-human wealth used in consumption decisions also affect housing demand. Other features of the model important for model simulation are outlined in the following section.

⁴ It is worthwhile to stress that no encompassing test of the two consumption models can be undertaken, as no re-estimation of the default model has been previously carried out. Discrimination among the two models on the ground of their relative performance in fitting the data is not of relevance, for the present purpose. Our interest is rather to assess the effects of simulating the model under two competing theoretical consumption frameworks on the composition of the monetary transmission mechanism.

4.3 NIDEM: MAIN FEATURES

Since 1969 the National Institute of Economic and Social Research has maintained and developed a large-scale econometric model of the UK economy which is widely recognised as one of the leading empirical domestic macroeconomic models. It is specifically designed to generate the Institute's UK economy quarterly forecasts, but it is also used to analyse individual macroeconomic relationships and to inform debates about macroeconomic policy.

In accordance with the leading paradigm in macroeconometric modelling, the Institute's domestic model can be described as Keynesian inasmuch as short-term fluctuations in output are largely determined by changes in the components of aggregate demand. Nonetheless, its long-run properties broadly reflect those of a neo-classical growth model, for the medium-to-long-term output response is primarily shaped by supply-side factors through technical progress and population growth. Coexistence of a neo-classical view of macroeconomic equilibrium with a new Keynesian view of short-term adjustments would imply that, while in the long run the level of real activities is independent of the steady-state inflation rate, in the short run adjustment costs and contractual arrangements prevent markets from clearing, inducing thereby potential output persistence and employment disequilibria. However, behavioural inflation non-neutralities within NiDEM's consumers' expenditure equation, as well as the lack of indexation of the tax system, cause inflation to affect long-run macroeconomic outcomes (see Young, 1997, for an analysis on the issue). As a result, the model leaves considerable scope for monetary and fiscal policy, primarily with temporary effects, and additionally it allows for some long-term consequences.

4.3.1 *The demand side*

Within the abovementioned framework, the model's equations are consistent with the imperfectly competitive market theory, as both the goods and labour markets contain a demand curve determining the quantity traded and price setting equations. Namely, the demand curve in the goods market consists of the domestic expenditure and trade equations, where domestic expenditure is given by (private and public) consumption and investment in both fixed capital and stocks.

Aggregate consumers' expenditure, as described by the model's default consumption function, is based on forward-looking dynamic optimisation in the presence of adjustment costs. Consumers are thought of as aiming towards particular steady-state consumption-to-income and total net wealth-to-income ratios. The model also captures the role of borrowing constraints by modelling consumer spending conditional on the flow of credit, while excluding net property income as this only affects consumption through its indirect impact on wealth. Inflation non-neutralities also feature in the equation as it allows for negative long-run effects from the level of *nominal* interest rates. As one of the aims of this chapter is to analyse the monetary transmission mechanism under the alternative consumption model described in section 4.2.3, the alternative model will eventually replace NiDEM's default consumption function. Aggregate consumption is split between durables and non-durables. The share of durable expenditure in total consumers' expenditure is positively related to the proportion of total consumption financed by credit and mortgage equity withdrawal and negatively related to real interest rates. The change in disposable income term in the equation allows for a transient effect on consumption, and this does not completely disappear in the long run. The treatment of public consumption is quite unusual. By default, it is used to target the ratio of general government expenditure-to-GDP, but it can be employed as a policy instrument to achieve alternative fiscal targets. For present purposes, we would rather switch this equation off and consider government procurement as exogenous.

Underlying the factor demand relationships in the model is a Cobb-Douglas production function, broadly similar in each sector of the economy and incorporating exogenous labour augmenting technical progress. Under the assumption that firms maximise the present discounted value of their cash flow subject to such a production function and an adjustment cost function which is linear in capital and investment, the optimum investment capital ratio depends on the expected investment rate itself and also on the expected gap between the marginal product of capital and its user cost. Analogously, stock levels are determined by forward-looking expectations in both output and the marginal financial cost of stockholding. The extent of companies balance-sheet disequilibrium is also a determining factor. Unlike investment in manufacturing and non-manufacturing sectors, public sector investment simply grows in line with public consumption. Firms' employment decisions are instead modelled by inversion of the production function and are defined in terms of hours of labour input.

Exports are described by overseas demand functions for domestically produced goods which depend upon world trade measures and relative prices defined for each category.

Total final expenditure, in turn, can either be satisfied from domestic or overseas production. Consistent with the imperfectly competitive framework, the allocation of the different categories of national and overseas production is defined by a system of demand curves which depend mainly on relative prices, although a time trend is allowed for as a proxy for international specialisation effects.

4.3.2 The supply side

As noted above, the supply side is extremely important in determining model properties, not only because the dynamic responses of these variables determine the outcome for price inflation but also because the long-run solution to these equations can be used to derive an expression for the long-run rate of unemployment, the NAIRU. The equation for average earnings has a long-run solution in which real wage costs depend on the level of productivity,

the unemployment rate and long-term unemployment, this latter term capturing upward pressures due to insider-outsider effects.

Direct taxes, indirect taxes and the relative price of imports have no long-run effects, although dynamic effects from changes in these wedge terms do arise. Prices in the goods market depend on costs (labour, import and stockholding), productivity and demand pressures. Adjustment costs imply that current prices depend heavily on past prices, but also expected movements in costs and demand. All of the trade-price equations exhibit both static and dynamic homogeneity and simply relate trade prices to world prices or a combination of world and UK prices. NiDEM's wage and price equations can be combined to form an expression for the NAIRU, the non-accelerating inflation rate of unemployment. Given the inflation neutrality characterising the system, the NAIRU will be independent of the level of inflation itself (see section 4.4.3), while it will be affected by the proportion of unemployment which is long term, changes in the wedge term and the real exchange rates.

The exchange rate plays a crucial part in the model, helping to determine output, inflation and the price level in both the short and long term. It is determined by an explicit forward-looking uncovered interest parity arbitrage condition. This implies a steady state in which the rate of change in the nominal exchange rate, and hence price inflation, is consistent with the nominal interest differential, whereas the current value of the exchange rate 'jumps' in response to anticipated future movements in interest rates. This would leave the equilibrium price level undetermined unless an interest rate feedback rule on inflation or another monetary aggregate is otherwise specified.

4.3.3 *The monetary stance*

The main policy instrument in the monetary sector is the Bank's base rate. This is given by the sum of an endogenous and an exogenous component. The endogenous component may be

set according to the deviation of the rate of inflation or a pre-selected nominal variable from its target. Here we consider two alternative monetary regimes. In the first, characterised by a floating exchange rate, the endogenous component of the interest rate varies endogenously so as to accommodate deviations of the *RPLXMIP* inflation rate from its desired path. In the second regime, both the effective exchange rate and the short-term interest rate are kept fixed at their baseline values, so as to imitate a fixed exchange rate regime.

4.3.4 The fiscal stance

The most important component of direct taxation on household income consists of taxes on non-property income. Variations in the tax yield net of mortgage interest tax relief are determined by applying variations in the basic tax rate to the net of allowance tax base. The latter is defined as wages and salaries plus ten per cent of any social benefits received by households. Taxes on property income have a similar structure, with the tax base given by the household gross operating surplus plus half of gross property income. For present purposes, the basic rate of income tax is modelled as a policy rule targeting deviations of the public deficit-to-GDP ratio from a desired target level.

4.4 THE SIMULATION EXPERIMENT

4.4.1 *The design*

The aim of our analysis is primarily to show how changes in policy-determined interest rates affect the UK economy, and particularly British private consumption. In light of this, we simulate a temporary, 50 basis point, reduction in the policy rate for eight quarters. The simulation is performed under both endogenous and exogenous nominal exchange rates and with the default and alternative specifications for aggregate consumers' expenditure imposed. The simulated effects on real GDP are decomposed both by GDP component and by transmission channel, with respect to each of the four selected scenarios. Six channels of interest rate transmission are reported: (i) a fiscal channel, (ii) a direct interest rate channel on consumers' expenditure for durable and non-durable goods, capturing intertemporal substitution effects, (iii) a cost-of-capital/rate-of-return channel on investment, (iv) an income/cash flow channel, (v) a wealth/asset prices channel, and (vi) an exchange rate channel.

As our aim is to show the sensitivity of the UK monetary transmission mechanism to changes in the monetary regime, we need to simulate a monetary shock which is applicable (and comparable) under both an inflation targeting rule and a fixed exchange rate regime, thus we shock the policy-controlled interest rate temporarily. However, two major caveats are necessary.

Firstly, it should be remembered that, to carry out such an experiment, we assume the economy to be in some initial equilibrium position prior to any monetary policy perturbation. In reality, though, the economy is continually affected by a variety of disturbances, and the aim of the monetary authority is to respond to such exogenous shocks in order to move nominal target variables (such as inflation), to desired levels. This has led model builders to

depict monetary policy as an endogenous reaction function so that the interest rate changes following simulation exercises are those required to bring the target variable to its desired path, subject to various constraints. Hence, in the case of inflation targeting, the default endogeneity of the monetary policy rule and the contemporaneous implementation of an impulse *via* the 'policy-controlled interest rate' might be viewed as an exercise investigating the implications of a 'policy error'. The monetary authority is, in the baseline scenario, following a constrained optimal path, given the monetary reaction function, but then decides to lower interest rates for two years. This implies that the monetary authority is initiating the shock rather than just responding to exogenous disturbances. In order to be able to represent a situation in which the authority is using its policy instrument to initiate the shock and, at the same time, responding to the resulting deviation of the target variable from its desired level, the base nominal interest rate is split in two components, one is exogenous whereas the other is endogenous. In this way, under inflation targeting, endogeneity of the monetary rule is maintained even during the period in which the shock is implemented. It should therefore be clear that our simulation experiments are designed *ad hoc* to elucidate model properties under alternative states-of-the-world, inasmuch as they are not reflecting realistic policy making. Results should therefore be interpreted with this in mind.

Secondly, it is our intention to evaluate whether the relative contribution of different monetary transmission channels is unaffected by changes in either private consumption specification or monetary regime. We must therefore recall that, with linear backward-looking macroeconomic models, the decomposition of a simulation into contributing channels is unique and independent of the order in which the decomposition is carried out, this is not true, however, when the expectations formation is explicitly forward-looking. For this reason, although the decomposition exercise for the above considered scenarios is undertaken by simulating the full NiDEM model with the various channels sequentially turned off in an order suggested by the model's structure, we continually repeat the experiment with different orderings to check for discrepancies. As differences are quite small and the ranking of

contribution across transmission channels does not change in the short term, we only report the sequential approach results.

We now turn to the analysis of the simulation exercises. Firstly, we evaluate the monetary-shock transmission process across the financial sphere. The impact on real GDP (decomposed by spending components), prices, and other macroeconomic variables of interest is assessed. The effects under an endogenous exchange rate (scenario *a*) are compared to those under a fixed exchange rate (scenario *b*); a comparison of the simulation results using the default consumption function (scenario *1*) and those using the alternative life-cycle function (scenario *2*) also features throughout.

4.4.2 The financial structure

In NiDEM, the transmission mechanism of monetary policy is modelled, to a large extent, as an interest rate transmission mechanism. The central bank sets the short-term interest rate, which then affects interest rates over the whole maturity spectrum, other asset prices and the exchange rate via the operation of a relatively simple term structure and arbitrage condition. Financial variables will then influence output and prices through their effects on individual spending components.

The responses of the relevant interest rates, asset prices and monetary aggregates following a half percentage point reduction in the policy rate are shown in Figures 4.1 and 4.2, for the default and alternative consumption specifications respectively. The comparison of rates' dynamics under inflation targeting and a fixed exchange rate regime is also reported throughout.

Figure 4.1: Monetary variables responses under a ‘disposable funds’ approach
0.5 percentage points reduction in the exogenous component of the interest rate

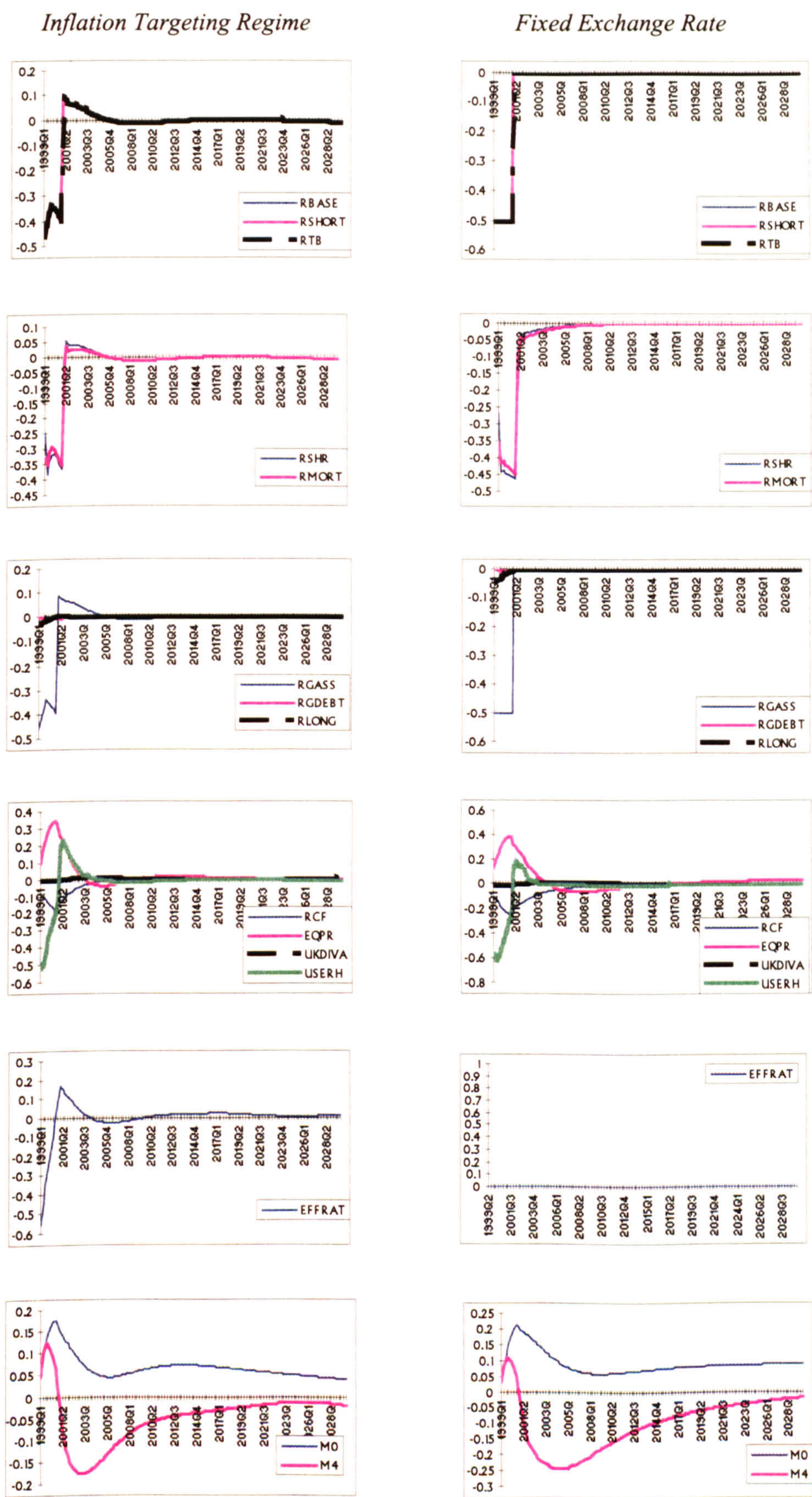
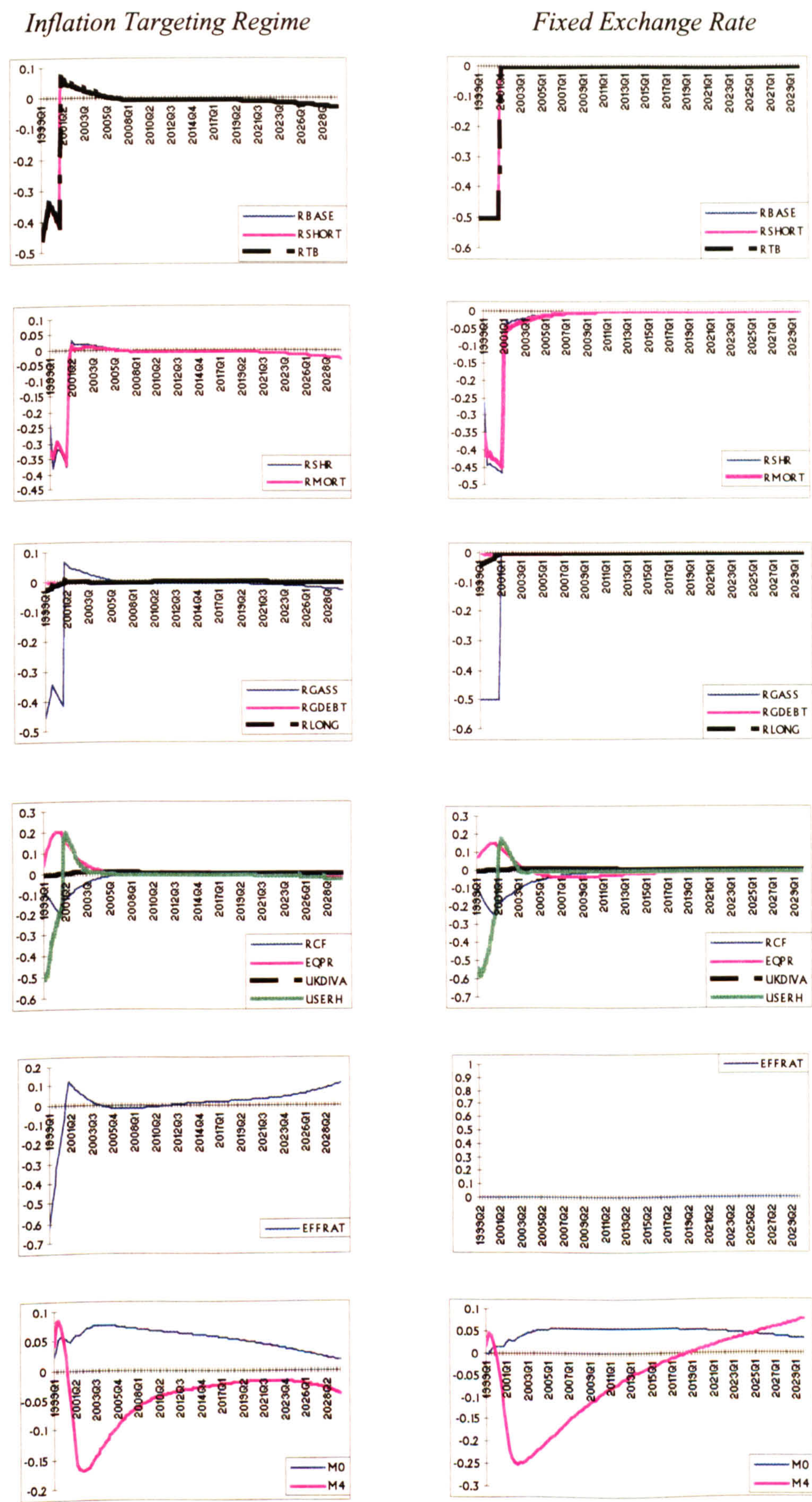


Figure 4.2: Monetary variables responses under a ‘life-cycle’ approach
0.5 percentage points reduction in the exogenous component of the interest rate



Taking the left-hand side of Figure 4.1 first, the most striking feature is that for the majority of interest rates employed within the model, the dynamic profiles cannot be distinguished from that of the policy rate, *RBASE* (see, for example, the Treasury bill rate, *RTB*, and the building society mortgage rate, *RMORT*). There are however two notable exceptions worth mentioning, these are the interest rate on government debt, *RGDEBT*, and the UK dividend yield, *UKDIVA*, both depend almost entirely on the long rate, *RLONG*. Movements in the equity price, *EQPR*, which reflect the balance-sheet position of financial companies, also seem to be somewhat divorced from the original policy rate shock, although short-term bank lending plays a central part in corporate finance. The real cost of finance, *RCF*, the main component through which the cost-of-capital channel is operating, cannot be directly compared with the other rates, as it refers to a post-tax real interest rate. Again, this is just a function of the Bank's base rate. The user cost of housing, *USERH*, reflects to a large extent the adjustment path of the policy rate and impressively resembles the most important asset price, the nominal exchange rate, *EFFRAT*. This undoubtedly constitutes the main monetary transmission channel to prices. In NiDEM, as we have discussed above, the nominal exchange rate is modelled in the form of a UIP condition and is treated in an explicit forward-looking way. That is, a reduction in the policy rate, with foreign rates unchanged, provokes an immediate devaluation which feeds into the wage-price system driving prices up. Given the temporary nature of the shock, however, the interest rate is expected to move back after eight periods, thereby inducing an *interim* revaluation of the nominal exchange rate. In contrast, the role of money is a passive one, in the sense that both broad (*M4*) and narrow (*M0*) money are demand determined.

It should be clear, therefore, that the whole interest rate transmission mechanism is centred on short-market rates. As a consequence, each spending component in NiDEM is likely to be strongly dependent on short-term interest rates. Nevertheless, if it is true that the financial structure determines which rates are modelled and how sensitive spending decisions are with respect to these rates, it is also true that the structure of balance-sheet positions also

determines the importance of income and cash-flow effects. In NiDEM, there exists an explicit banking sector, whose balance-sheet items entering households' net wealth (i.e. liquid deposits, mortgage and credit lending), influence both consumers' expenditure and investment in private dwellings. In this way, these variables may capture both changes in interest rates (and intertemporal substitution effects), and a direct credit channel on household demand, thus allowing a complete assessment of the role the financial structure has in an economy.

Moving on to the comparison of interest rate and asset price responses under a pegged nominal exchange rate, it is evident that when an inflation targeting rule is at work, interest rate responses are slightly weaker overall. This is because, even during the first eight quarters, endogenous accommodation of the shock is engineered. Moreover, under a fixed exchange rate regime, no overshooting occurs during the periods immediately following the shock, whereas overshooting is present with an inflation targeting rule. The comparison of Figures 4.1 and 4.2 is striking. With the inflation targeting regime, we notice that the long-run non-neutralities present characterise the responses of all rates in Figure 4.2, whereas this is not the case with an exogenous interest rate. Furthermore, under both monetary regimes, the use of an alternative equation for private consumption leads to a lower interest rate sensitivity. In particular, the response of narrow money demand is smaller and somewhat different following the interest rate reduction. Long-run interest rate non-neutralities and a low interest rate sensitivity are generally viewed as inherent properties of any neo-classical model with a forward-looking consumption function that explicitly contains Ricardian non-neutralities.

4.4.3 Macroeconomic responses following a monetary loosening

The macroeconomic effects of a change in the market interest rate depend upon the scenario considered, that is the chosen monetary regime and consumption model. Analysis of simulation results is organised as follows.

Table 4.1: Macroeconomic responses under a 'disposable-fund' consumption function

Scenario 1a: 0.5% temporary reduction of the exogenous component of the policy interest rate under inflation targeting regime, standard consumption function

	Year 1	Year 2	Year 3	Year 4	Year 5
GDP components					
GDP	0.15	0.20	0.07	- 0.02	- 0.06
Consumers' expenditure	0.10	0.18	0.09	0.01	- 0.04
Investment	0.07	0.07	0.02	0.00	- 0.00
Trade balance	- 0.03	- 0.06	- 0.05	- 0.03	- 0.02
Unemployment	- 2.66	- 5.42	- 5.08	- 3.47	- 1.72
Disposable income	- 0.06	0.00	0.05	0.04	- 0.01
Wealth components					
Net Wealth Households	0.17	0.22	0.04	- 0.08	- 0.15
Household Credit	0.43	0.86	0.74	0.45	0.19
Mortgage debt	0.07	0.17	0.19	0.16	0.14
Wages and Prices					
Wages and Salaries	0.20	0.39	0.26	0.10	0.02
Import Prices	0.26	0.14	- 0.02	- 0.03	- 0.03
Inflation	0.07	0.03	- 0.01	- 0.02	- 0.02
Government Accounts					
Debt to GDP ratio	- 0.71	- 1.41	- 1.50	- 1.29	- 1.08
Surplus to GDP ratio	0.07	0.16	0.09	0.01	- 0.02
Standard rate of income tax	- 0.01	- 0.06	- 0.08	- 0.07	- 0.06

Scenario 2a: 0.5% temporary reduction of the exogenous component of the policy interest rate under fixed exchange rate, standard consumption function

	Year 1	Year 2	Year 3	Year 4	Year 5
GDP components					
GDP	0.17	0.23	0.13	0.05	- 0.00
Consumers' expenditure	0.13	0.24	0.16	0.08	0.01
Investment	0.11	0.11	0.06	0.03	0.02
Trade balance	- 0.09	- 0.13	- 0.09	- 0.06	- 0.04
Unemployment	- 2.85	- 5.76	- 6.20	- 5.36	- 3.91
Disposable income	- 0.05	- 0.03	0.06	0.07	0.03
Wealth components					
Net Wealth Households	0.19	0.24	0.06	- 0.08	- 0.19
Household Credit	0.48	1.09	1.07	0.80	0.51
Mortgage debt	0.08	0.21	0.25	0.25	0.23
Wages and Prices					
Wages and Salaries	0.22	0.44	0.35	0.20	0.11
Import Prices	0.01	0.03	0.03	0.01	- 0.01
Inflation	0.03	0.05	0.01	- 0.01	- 0.02
Government Accounts					
Debt to GDP ratio	- 0.77	- 1.69	- 2.05	- 2.01	- 1.91
Surplus to GDP ratio	0.07	0.21	0.14	0.06	0.02
Standard rate of income tax	- 0.01	- 0.07	- 0.10	- 0.10	- 0.10

Scenario 1a: The upper panel of Table 4.1 summarises the responses obtained with the inflation targeting regime and default consumption function in place. The 50-basis-point reduction in the policy-determined interest rate for two years brings about a devaluation of sterling, as we saw above. The loosening of monetary conditions creates inflationary pressure for both real output and prices. Inflation rises by 0.7 per cent during the first year of the shock, whereas endogenous monetary-rule accommodation curbs its growth to 0.3 per cent above baseline in the final quarter of the perturbation. Once the interest-rate stimulus is turned off, inflation overshoots its target level and remains below baseline for most of the simulation period. This tightening manifests itself, in part, *via* a rise of the nominal short-term interest rate, peaking some 10 basis points above its baseline level in year 3, and, in part, *via* an increase in the exchange value of sterling during years 3 - 5 (see Figure 4.1). The nominal exchange rate grows by almost 0.2 percentage points in the first quarter following the removal of the shock.

More importantly, real interest rates rise above base values so that the real exchange rate rises above baseline for some three years. The tightening of monetary conditions that results suppresses the inflationary pressure on aggregate demand and helps price inflation move towards its target level. The latter adjustment occurs due to second-round effects from aggregate demand onto prices and via the pass-through of declining import prices to consumer prices.

The slowdown, however, is delayed, as the level of output remains above base in year 3 despite the policy restriction, a result which is due to the economy's intrinsic adjustment costs. Output is above base for more than three years, peaking at the end of the second year with GDP 0.2 per cent above baseline. The same is true for investment and consumers' expenditure. Nonetheless, whereas investment grows by 0.07 per cent of baseline GDP due to the initial fall in the real cost of finance, private consumption is driven up by 0.18 percent of baseline GDP, similar to the GDP response. The boom in consumption reflects both an improvement in households' net wealth, which rises by 0.22 per cent at the end of the second

year, and, above all, an increase of 0.9 per cent in consumer credit. The robust and long-lasting response of households' credit, together with the modest and transitory worsening of their disposable income, emphasises the significance of the households' debt position. Upward pressures in wages are also found to be strongly persistent and, thereby, responsible for the medium-term improvement in households' disposable income. The trade balance deterioration is given by the mirror image of the internal demand's dynamics. The 6 percentage point reduction in the current account ratio during year 2 is determined by the degree of openness in the UK economy, and the expansion in domestic demand, triggered by the inflationary monetary policy, results in higher imports. This is, however, partially offset by the gain in competitiveness following the endogenous devaluation of sterling during the first two years of the simulation.

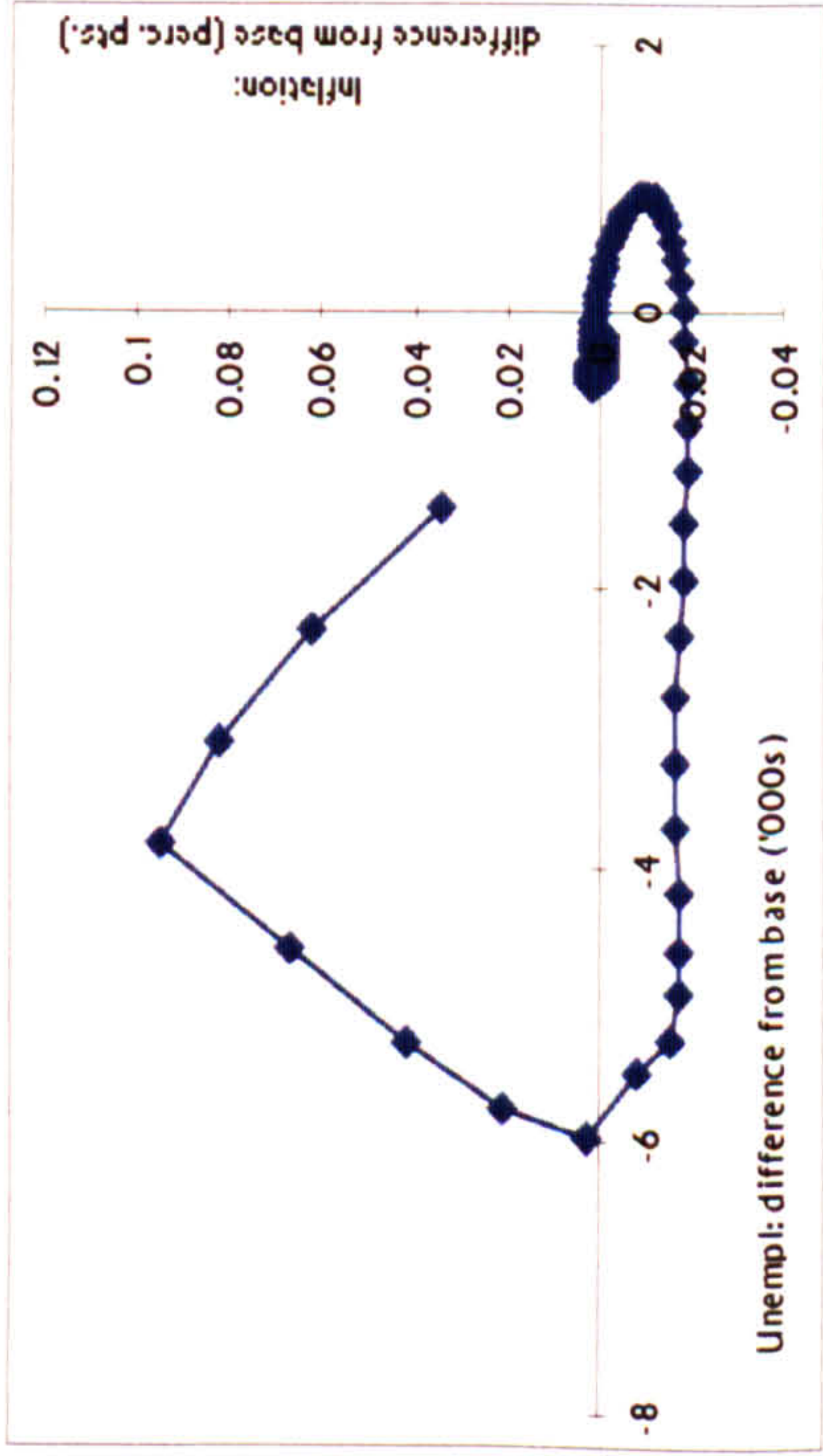
Finally, there is an overall improvement in the general government sector following the policy-determined interest rate reduction. The prolonged expansion of the tax base provides a lasting boost for the surplus to GDP ratio as it is still above baseline values after five years. Similarly, the debt to GDP ratio falls by more than 2 percentage points after three years, thereby inducing a reduction in the interest burden. The combined effect of the larger tax base and lower interest burden allows the basic rate of income tax to fall and remain below baseline values for the entire simulation horizon.

In the long run, nominal and real interest rates along with the nominal and real exchange rate return to baseline values, providing evidence that the model is inflation neutral. It is therefore the case that in the long run the Phillips curve is approximately vertical, as is apparent from Figure 4.3. The Figure combines together unemployment and inflation responses following a temporary monetary relaxation in order to obtain a Phillips-curve diagram. The familiar anti-clockwise dynamics show a peak at the end of the fourth quarter, some 0.1 percentage points above baseline, whereas the largest impact on real activity, a fall of 6,000 units in unemployment, occurs when the shock ends. There is considerable inertia in the adjustment

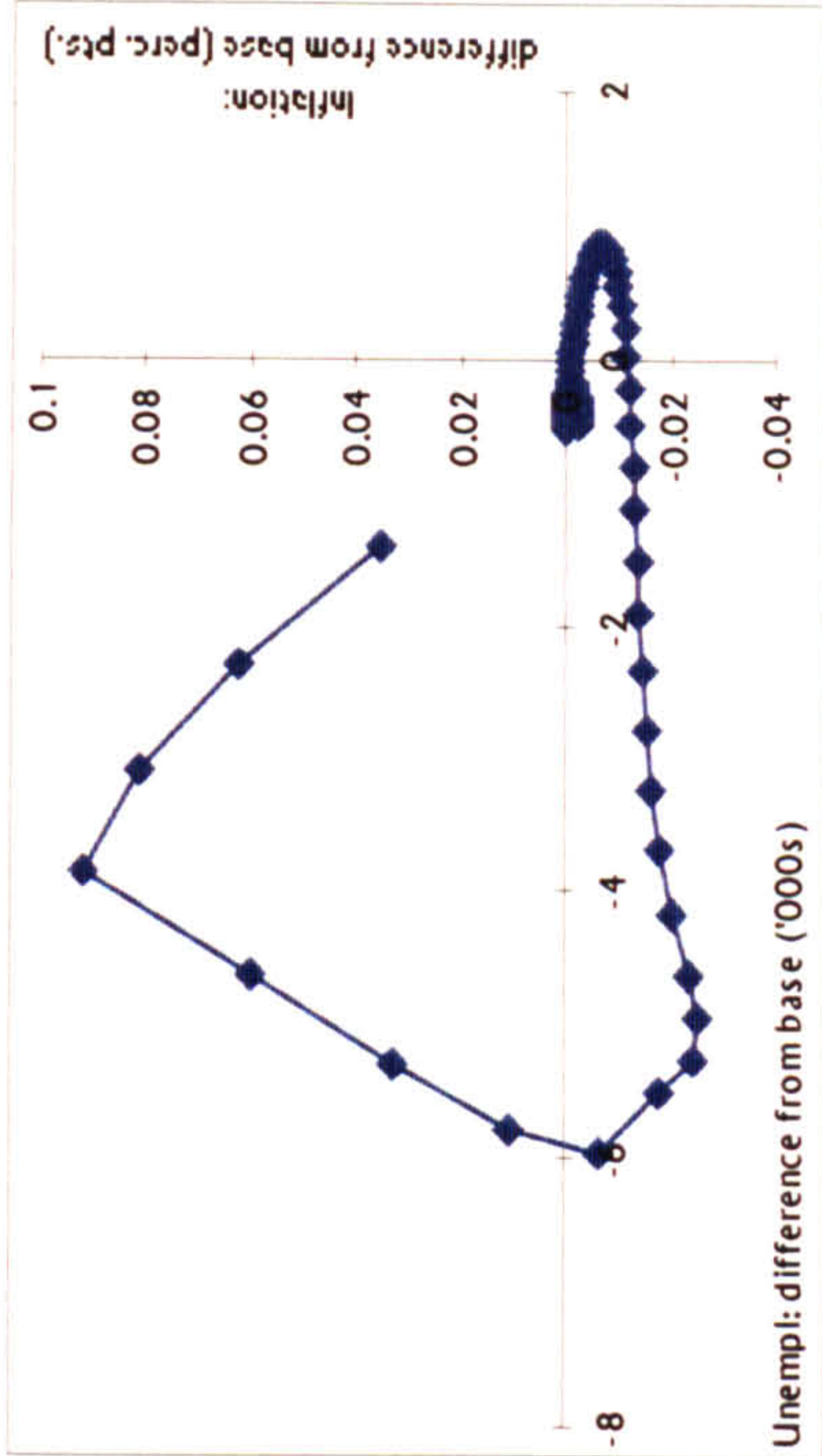
towards equilibrium, although ultimately there is no trade-off between employment and price stability.

Figure 4.3: Unemployment vs. inflation responses to a monetary loosening

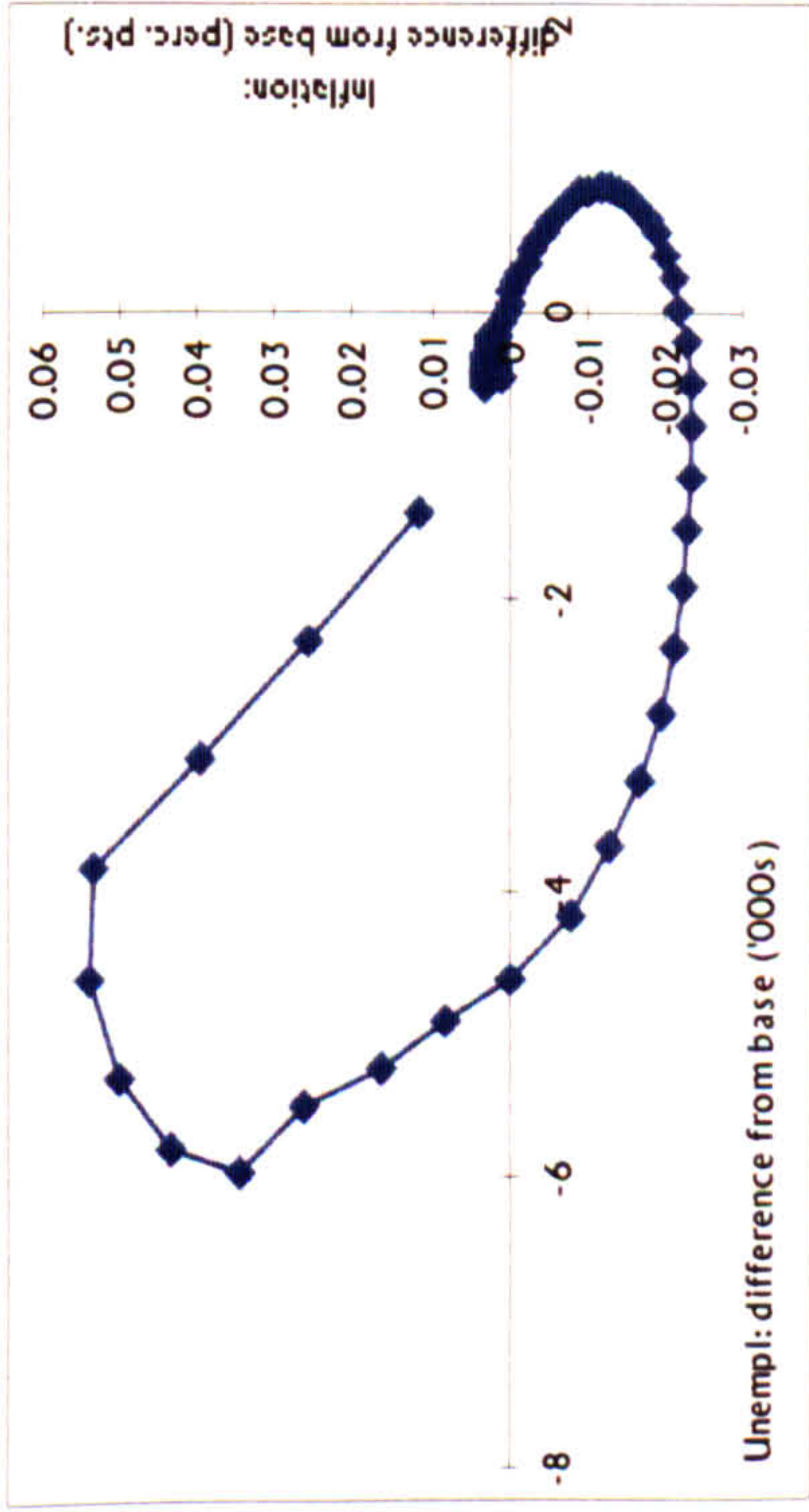
Scenario 1a



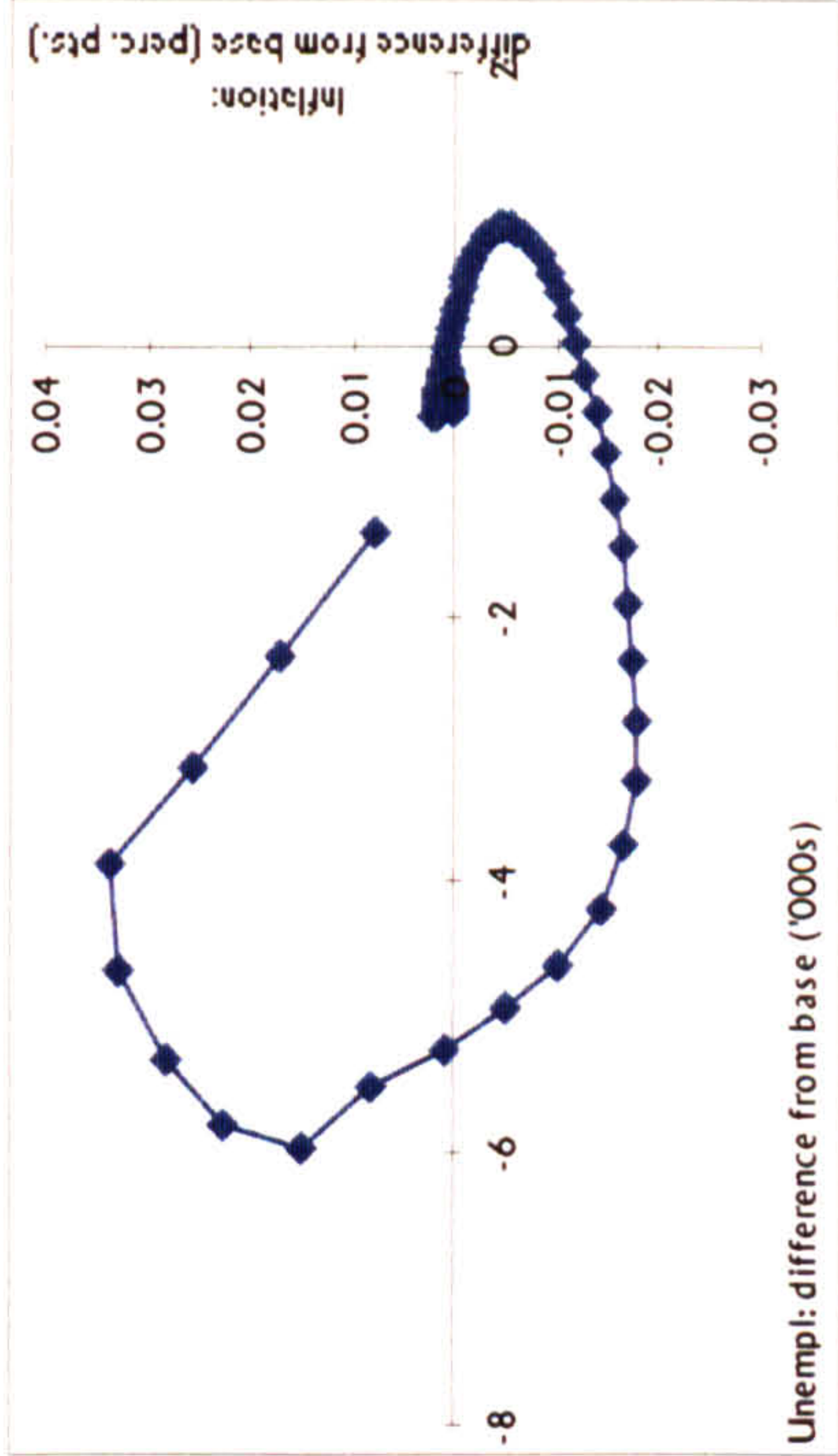
Scenario 1b



Scenario 2a



Scenario 2b



Scenario 2a: The lower panel of Table 4.1 contains the simulation results under a fixed exchange rate regime and the default consumption function. The results, while sharing many of the qualitative features discussed for *Scenario 1a* above, show more pronounced deviations from baseline values, with the exception of the import price response. This arises due to the fact that an exogenous (nominal) exchange rate closes off one channel of interest rate transmission. Implications are twofold. On the one hand, it inhibits the price competitiveness gain present in the previous experiment. As there is no initial depreciation of the exchange rate, import prices hardly move away from base and the increase in exports is negligible. On the other hand, however, the absence of an exchange rate pass-through onto consumer prices eliminates a channel through which monetary policy operates and price stability is, thereby, ensured. The Phillips-curve shown in Figure 4.3, scenario 2a illustrates the combined consequences of these two effects. The inflationary pressure following the monetary relaxation under a fixed exchange rate is half the size of the corresponding effect under inflation targeting, as no depreciation takes place. Despite this, inflation takes one year longer to return to base. More importantly, the utter exogeneity of the interest rate in this simulation amplifies the magnitude of the shock during the first eight quarters compared to that in the previous experiment. It follows that the macroeconomic responses will be generally larger under this scenario, as the initial stimulus to the policy rate is larger.

Real GDP increases by 0.23 per cent in year 2, remaining above during following years and standing 0.05 per cent above base in year 4. Similarly, consumption remains above its baseline value throughout the simulation horizon, with an increase of 0.24 per cent of baseline in the second year. The rise in investment is also more pronounced, still standing above baseline at the end of the fifth year. The deterioration of the trade balance is sizeable, and in the second year more than counters the contribution of investment to the expansion in demand. This is due to both stronger leakage of domestic demand into imports and a marginal export response. As the stimulus to the economy is larger than that under the previous scenario, the improvement in the government accounts is also amplified.

Table 4.2: Macroeconomic responses under a 'life-cycle' consumption function

Scenario 1b: 0.5% temporary reduction of the exogenous component of the policy interest rate under inflation targeting regime, alternative consumption function

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 30
GDP components						
GDP	0.09	0.10	0.04	0.01	- 0.01	- 0.02
Consumers' expenditure	0.01	0.03	0.03	0.02	0.01	0.00
Investment	0.07	0.07	0.03	0.01	0.01	0.00
Trade balance	- 0.00	0.00	- 0.02	- 0.03	- 0.02	- 0.02
Unemployment	- 1.70	- 3.21	- 3.01	- 2.17	- 1.32	1.05
Disposable income	- 0.09	- 0.07	- 0.00	0.02	0.01	0.00
Wealth components						
Net Wealth Households	0.11	0.15	0.07	0.01	- 0.03	0.02
Household Credit	0.41	0.82	0.71	0.45	0.23	0.06
Mortgage debt	0.07	0.15	0.17	0.15	0.13	0.05
Wages and Prices						
Wages and Salaries	0.14	0.26	0.18	0.08	0.05	- 0.02
Import Prices	0.29	0.17	0.01	- 0.01	- 0.01	- 0.08
Inflation	0.07	0.02	- 0.02	- 0.02	- 0.01	- 0.00
Government Accounts						
Debt to GDP ratio	- 0.28	- 0.78	- 1.02	- 0.97	- 0.91	- 0.02
Surplus to GDP ratio	0.04	0.10	0.07	0.02	0.01	- 0.01
Standard rate of income tax	- 0.00	- 0.04	- 0.05	- 0.05	- 0.05	- 0.03

Scenario 2b: 0.5% temporary reduction of the exogenous component of the policy interest rate under fixed exchange rate, alternative consumption function

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 30
GDP components						
GDP	0.07	0.06	0.03	0.01	0.00	- 0.00
Consumers' expenditure	0.00	0.01	0.01	0.00	- 0.00	- 0.01
Investment	0.09	0.10	0.05	0.03	0.02	0.00
Trade balance	- 0.04	- 0.05	- 0.03	- 0.03	- 0.02	0.00
Unemployment	- 1.30	- 2.00	- 1.82	- 1.28	- 0.63	0.35
Disposable income	- 0.10	- 0.15	- 0.06	- 0.00	- 0.01	- 0.00
Wealth components						
Net Wealth Households	0.09	0.10	0.02	- 0.03	- 0.07	0.16
Household Credit	0.45	0.99	0.93	0.66	0.41	0.04
Mortgage debt	0.08	0.19	0.21	0.19	0.18	0.04
Wages and Prices						
Wages and Salaries	0.11	0.21	0.15	0.06	0.02	- 0.01
Import Prices	0.00	0.01	0.01	0.00	- 0.01	0.00
Inflation	0.02	0.02	- 0.00	- 0.02	- 0.02	0.00
Government Accounts						
Debt to GDP ratio	- 0.30	- 0.78	- 1.03	- 1.01	- 0.99	- 0.27
Surplus to GDP ratio	0.03	0.11	0.08	0.03	0.02	- 0.01
Standard rate of income tax	- 0.00	- 0.04	- 0.06	- 0.05	- 0.06	- 0.06

This results in a more pronounced and lasting reduction in income taxation, which in turn reverses the sign of the disposable income response as the stimulus to the policy rate comes to an end.

Scenario 1b: The upper panel of Table 4.2 reports the results under an inflation targeting regime and the modified life-cycle consumption function. This experiment highlights the key role played by the consumers' expenditure equation, as consumption's share in changes to GDP is larger than that for any other component. Also its interest rate responsiveness is crucial when determining the impact of monetary policy on the economy as a whole. Simulation results are therefore amazingly clear-cut. If households are assumed to make their spending decisions on the basis of their life-cycle permanent income and to discount future income at a higher rate than the market rate, then the interest sensitivity of consumption falls dramatically. With this policy scenario, private consumption increases by 0.03 percent of baseline GDP at the end of the second year, and moves slowly back thereafter. Investment responses are exactly the same as those for scenario 1a, and there's practically no deterioration of the current account. This is due to the small amount of import leakage from private consumption as a result of its weak growth.

As for asset components, consumers' credit and mortgage debt are marginally changed. Households' net wealth falls, mainly due to lower money balances, which are, as already noted, demand determined. Disposable income falls by more than that under scenario 1a. This is due to less demand pressure on wages and salaries and a smaller income tax reduction. The latter, a consequence of the small expansion of the tax base in this exercise, results in a modest PSBR to GDP ratio improvement and slight debt relief. As expected, the supply side is only marginally affected by modifications in consumption behaviour as both the import price and inflation dynamic responses (Figure 4.3) generally resemble those for scenario 1a.

Scenario 2b: The lower panel of Table 4.2 shows the results under a fixed exchange rate regime and the alternative life-cycle consumption function. As with scenario 2a, there is the

absence of an exchange rate channel of monetary transmission. This is confirmed by looking at the investment, trade balance and price responses. As there is no initial depreciation of the exchange rate, import prices remain around base values and any increase in exports is negligible. Thus, during the first two years, the current account deteriorates more than with scenario *1b*. Furthermore, as there is no correction to the inflationary disturbance during the perturbation period, the increase in investment is more pronounced during the first eight quarters and lasts until the end of year 5. The effects on credit and mortgage debt are also reinforced due to the lack of endogeneity of the monetary rule. However, in contrast with the results for scenario *2a*, where the exchange rate is also fixed, consumption responsiveness is here further reduced, as compared to that with inflation targeting. This is due to the larger fall in disposable income, following the larger reduction in the interest rate. Given that consumers excessively discount the future and that there is a crucial part played by discounted flows of future income within a life-cycle consumption model, income reductions quickly feed into consumption. As a consequence, consumers' expenditure is markedly reduced throughout the simulation period. This is the reason why, under this scenario, the effects of the initial disturbance on the economy are generally smaller. GDP, unemployment and nominal wage responses, all determined by consumption movements, are smaller than under inflation targeting. The impact on total net wealth is also lessened, as lower money holdings reduce the stream of property income. This results in a perverse disposable income-consumption spiral. Public account responses are slightly larger than under scenario *1b*. It therefore seems that the lack of accommodation of the initial shock more than offsets the fall in disposable income, at least in the short run.

4.4.4 Decomposition of transmission channels for selected scenarios

The structure of NiDEM allows the total effects of the simulated interest rate changes on spending components to be attributed to the following transmission channels: (a) the direct

channel, which represents the intertemporal substitution effect of the change in interest rates on private consumption for both durable and non-durable goods; (b) the fiscal channel, which captures the effects of movements in the policy interest rate on government financing and, thereby, on households' spending decisions; (c) the cost-of-capital channel, capturing the effects of the user cost of capital on investment in housing, manufacturing and non-manufacturing sector, as well as on inward/outward direct and portfolio investments; (d) the cash-flow channel, which proxies for the impact of interest rate changes on the flows of earnings, interest and dividend payments between sectors; (e) the wealth channel, capturing the effects of interest rate disturbances on expenditure through the response of financial asset prices, house prices as well as direct changes in the entity of each households' balance-sheet component (i.e. liquid assets, equities and pension funds, credit, mortgages and houses); (f) the exchange rate channel, which comprises all the effects engineered by the response of the exchange rates to changes in the interest rate.

The relative importance of the various transmission channels to the overall result is analysed empirically by closing off the different channels sequentially, in the logical order suggested by the structure of NiDEM (reported above). This implies that the contribution each channel makes is strictly dependent on the sequence of elimination. This is because in each case a different model is simulated. However, as previously mentioned, a double-check of results is undertaken by simulating one channel at a time. Results show that differences in the size of the contribution made by each transmission channel appear to be negligible in the short term, although discrepancies do increase somewhat towards the end of the simulation period. The advantage of the chosen approach is that the sum of the partial effects exactly equates to the total effect, inasmuch as interdependence among channels is internalised.

The contribution each monetary transmission channel makes to changes in GDP and the main spending components, for each of the four selected scenarios, is reported in Tables 4.3 to 4.6. Decomposition by transmission channel with respect to GDP and aggregate consumers' expenditure is further illustrated in Charts 5 and 6, respectively. At a glance, the results

convey the idea that the choice of monetary regime and the assumption regarding consumption behaviour (among other things), matter when determining the relative contributions the various monetary transmission channels make to the effects of a policy change.

Let us first focus on the default consumption function simulation results (Tables 4.3 and 4.4 and scenarios *1a* and *2a* in Figures 4.4 and 4.5). Under the endogenous monetary rule, the main interest rate transmission channel to real output is the direct channel, accounting for approximately half of its variation during the first two years. The exchange rate and wealth effect jointly explain the remaining GDP movements during this period. The GDP fluctuations arising from the wealth effect are due to one component of the households' balance-sheet, that is credit. When the shock to interest rates ends, both the exchange rate and credit effects ease, while the fiscal channel becomes more important. The relevance of the intertemporal substitution effect on consumption is amplified when the exchange rate channel is turned off, as it becomes responsible for 0.17 per cent of a 0.23 per cent increase in GDP during the second year of the simulation. The credit channel provides the second largest contribution to the GDP response in the first two years, but, as is the case with inflation targeting in place, its contribution diminishes thereafter, while the fiscal channel's contribution grows progressively. The negative income effects also increase steadily over the medium term. In summary, both the ranking and the time profile of the various transmission channels do not change when consumption responses are considered, exceptions being the exchange rate and fiscal channels. The exchange rate channel is ineffective, whereas the fiscal channel is important when explaining consumption movements.

Let us now turn to assess the simulation results obtained when the model is simulated with a life-cycle consumption function (Table 4.5 and 4.6 and scenarios *1b* and *2b* in Figures 4.4 and 4.5). Under an inflation targeting rule, real GDP is driven by exchange rate movements, with the exchange rate channel determining more than half of its variation in year 2. The other channels are generally weaker. When the exchange rate is exogenous, the cost of capital

channel gives rise to the largest impact, explaining almost all of the change in GDP during years 1 and 2. The fiscal channel, on the other hand, makes the largest contribution during the medium term. Focusing on consumption again, the story changes substantially from that discussed above. The cash flow channel produces the largest (negative) impact on consumption when an inflation targeting regime is in place. Its effect builds over time, but is offset by the combined effects of the cost of capital and fiscal channels. When the exchange rate channel is closed off, the cost of capital channel delivers a positive contribution to consumption variations during the first year, but this turns increasingly negative soon after the shock ends. From the second year onwards, the government financing channel becomes the main method of transmission of the shock on to consumption, this is closely followed by a strengthened direct channel.

In summary, the transmission channels decomposition corroborates our interpretation of the different macroeconomic responses to the monetary shock obtained under each of the scenarios. Our results show that when consumers are assumed to make their spending decisions within a life-cycle perspective, while ‘excessively’ discounting the future, the contribution consumption makes to GDP changes is very small. Decomposing GDP responses by transmission channel shows that the main contributions come from monetary transmission mechanisms that affect either exports (the exchange rate channel) or investment (the cost of capital channel), as any consumption effect is negligible. Switching from an inflation targeting regime to a pegged (nominal) exchange rate magnifies the importance of the two domestic monetary transmission channels present. Both these channels, the intertemporal substitution (direct) effect and repercussions from government financing, affect real output through their impact on consumers’ expenditure. The former is important when households are assumed to make their choices according to a ‘disposable funds’ approach, and the latter is significant regardless the consumption model adopted.

Table 4.3: Decomposition of transmission channels (scenario 1a)

Scenario 1a. Inflation Targeting Regime - (standard consumption function)
Temporary Reduction of 1/2 Percentage Point in the Exogenous Component of Short-term Interest Rate

Year	Total	Fiscal stance	Direct channel	Cost of capital	Cash flow	Liquidity	Fin. assets	Credit	Mortgages	Housing	Wealth
GDP ^(a)											
1	0.15	0.01	0.06	0.02	-	0.01	-	0.00	0.02	0.01	0.03
2	0.20	0.03	0.09	0.01	-	0.01	-	0.00	0.03	0.01	0.05
3	0.07	0.04	0.03	0.01	-	0.01	-	0.00	-	0.00	- 0.01
4	- 0.02	0.03	-	0.00	-	0.01	-	0.00	-	-	- 0.03
5	- 0.06	0.03	-	0.01	-	0.02	-	0.00	-	-	- 0.02
30	0.01	0.01	0.02	0.01	-	0.01	-	0.00	-	-	- 0.00
Consumers' expenditure ^(b)											
1	0.10	0.01	0.09	0.02	-	0.01	-	0.00	0.03	0.01	0.03
2	0.18	0.04	0.15	0.04	-	0.02	-	0.00	0.04	0.00	0.05
3	0.09	0.05	0.08	0.03	-	0.02	-	0.00	0.01	0.00	0.00
4	0.01	0.06	0.01	0.01	-	0.02	-	0.00	-	0.00	- 0.02
5	- 0.04	0.05	-	0.00	-	0.04	-	0.00	-	0.00	- 0.03
30	0.02	0.02	0.01	0.01	-	0.01	-	0.00	0.00	0.00	- 0.01
Investment ^(b)											
1	0.07	0.01	0.00	0.04	-	0.00	-	0.00	0.01	0.01	0.02
2	0.07	0.01	0.01	0.03	-	0.00	-	0.00	0.01	0.01	0.03
3	0.02	0.01	0.00	0.02	-	0.00	-	0.00	-	0.00	- 0.00
4	0.00	0.01	-	0.01	-	0.00	-	0.00	-	-	- 0.01
5	- 0.00	0.01	-	0.01	-	0.00	-	0.00	-	-	- 0.00
30	0.00	0.00	0.00	0.00	-	0.00	-	0.00	0.00	0.00	- 0.00
Real trade balance ^(b)											
1	- 0.03	0.01	-	0.02	-	0.01	-	0.00	-	0.01	- 0.02
2	- 0.06	0.02	-	0.01	-	0.01	-	0.00	-	-	- 0.03
3	- 0.05	0.03	-	0.00	-	0.01	-	0.01	-	0.01	- 0.01
4	- 0.03	0.03	-	0.00	-	0.01	-	0.00	-	0.01	0.01
5	- 0.02	0.03	-	0.01	-	0.02	-	0.00	-	0.01	0.02
30	- 0.01	0.02	-	0.00	-	0.00	-	0.01	-	0.00	0.01

(a) Percentage difference

(b) Difference as proportion of GDP

Table 4.4: Decomposition of transmission channels (scenario 2a)

Scenario 2a. Fixed Exchange Rate Regime - (standard consumption function)
Temporary Reduction of 1/2 Percentage Point in the Exogenous Component of Short-term Interest Rate

Year	Total	Fiscal stance	Direct channel	Cost of capital	Cash flow	Liquidity	Fin. assets	Credit	Mortgages	Housing	Wealth
GDP ^{b)}											
1	0.17	0.01	0.10	0.04	- 0.02	-	- 0.00	0.02	0.01	0.01	0.04
2	0.23	0.04	0.17	0.02	- 0.05	-	0.00	0.04	0.01	0.01	0.07
3	0.13	0.06	0.11	0.02	- 0.06	-	-	0.01	-	0.00	0.00
4	0.05	0.07	0.03	0.02	- 0.05	0.00	- 0.01	- 0.01	- 0.01	-	- 0.03
5	- 0.00	0.08	- 0.01	0.02	- 0.06	0.00	- 0.01	- 0.02	- 0.00	-	- 0.03
30	0.01	0.01	- 0.01	- 0.02	0.03	0.00	- 0.01	- 0.00	0.00	0.00	- 0.01
Consumers' expenditure ^{b)}											
1	0.13	0.01	0.12	- 0.01	- 0.02	-	0.00	0.03	0.01	0.00	0.04
2	0.24	0.04	0.23	- 0.01	- 0.07	-	0.00	0.05	0.00	0.00	0.06
3	0.16	0.06	0.16	0.00	- 0.08	0.00	-	0.02	- 0.01	0.00	0.01
4	0.08	0.08	0.08	0.02	- 0.08	0.00	- 0.01	- 0.01	- 0.01	0.00	- 0.02
5	0.01	0.09	0.02	0.02	- 0.09	0.00	- 0.01	- 0.03	- 0.00	0.00	- 0.03
30	0.02	0.09	- 0.06	- 0.05	0.05	0.00	- 0.01	- 0.00	0.00	0.00	- 0.01
Investment ^{b)}											
1	0.11	0.01	0.01	0.07	- 0.01	-	0.00	0.00	0.01	0.01	0.02
2	0.11	0.01	0.02	0.06	- 0.01	-	0.00	0.00	0.01	0.01	0.03
3	0.06	0.01	0.02	0.04	- 0.01	-	0.00	0.00	- 0.00	0.00	-
4	0.03	0.01	0.00	0.03	- 0.01	-	0.00	- 0.00	- 0.00	- 0.01	- 0.01
5	0.02	0.02	- 0.01	0.02	- 0.01	-	0.00	- 0.00	- 0.00	- 0.00	- 0.01
30	0.00	0.00	- 0.00	- 0.00	0.01	0.00	- 0.00	- 0.00	0.00	0.00	- 0.00
Real trade balance ^{b)}											
1	- 0.09	- 0.00	- 0.04	- 0.03	0.01	0.00	0.00	- 0.01	- 0.01	- 0.00	- 0.02
2	- 0.13	- 0.01	- 0.09	- 0.02	0.03	0.00	- 0.00	- 0.02	- 0.01	- 0.01	- 0.03
3	- 0.09	- 0.02	- 0.08	- 0.02	0.03	0.00	- 0.01	- 0.01	0.00	-	- 0.01
4	- 0.06	- 0.03	- 0.05	- 0.02	0.04	0.00	- 0.00	0.00	0.00	0.00	0.00
5	- 0.04	- 0.03	- 0.03	- 0.02	0.04	-	0.00	0.01	0.00	0.00	0.01
30	- 0.02	- 0.09	0.06	0.04	- 0.03	-	0.00	0.00	- 0.00	- 0.00	0.00

Notes: see Table 3

Table 4.5: Decomposition of transmission channels (scenario 1b)

Scenario 1b. Inflation Targeting Regime - (alternative consumption function)
Temporary Reduction of 1/2 Percentage Point in the Exogenous Component of Short-term Interest Rate

Year	Total	Fiscal stance	Direct channel	Cost of capital	Cash flow	Liquidity	Fin. assets	Credit	Mortgages	Housing	Wealth	Exch. rate
GDP ^{b)}												
1	0.09	0.01	0.00	0.03	- 0.01	0.00	- 0.00	- 0.00	0.00	0.01	0.00	0.04
2	0.10	0.02	0.01	0.02	- 0.02	0.00	0.00	- 0.00	0.00	0.01	0.02	0.06
3	0.04	0.02	0.00	0.01	- 0.03	0.00	- 0.00	0.01	0.00	0.00	0.01	0.03
4	0.01	0.02	- 0.00	0.01	- 0.03	0.00	- 0.00	0.00	- 0.00	0.00	0.00	0.00
5	- 0.01	0.02	- 0.00	0.01	- 0.03	- 0.00	- 0.00	- 0.00	- 0.00	0.01	0.00	- 0.01
30	- 0.02	- 0.02	- 0.01	- 0.01	0.02	0.00	0.00	0.00	- 0.00	- 0.00	0.00	0.00
Consumers' expenditure ^{b)}												
1	0.01	0.01	0.01	0.01	- 0.01	0.00	- 0.00	- 0.00	0.00	0.00	0.00	0.00
2	0.03	0.02	0.01	0.01	- 0.03	0.00	0.00	- 0.00	0.00	0.00	0.00	0.01
3	0.03	0.03	0.01	0.02	- 0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01
4	0.02	0.03	0.01	0.02	- 0.05	0.00	- 0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.03	0.00	0.02	- 0.05	- 0.00	- 0.00	0.00	- 0.00	0.00	0.00	- 0.00
30	0.00	- 0.00	0.01	0.08	- 0.09	- 0.00	0.00	- 0.00	- 0.00	0.00	0.00	- 0.00
Investment ^{b)}												
1	0.07	0.01	0.00	0.04	- 0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
2	0.07	0.01	0.00	0.04	- 0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
3	0.03	0.01	0.00	0.02	- 0.00	0.00	- 0.00	0.00	0.00	- 0.00	- 0.00	0.00
4	0.01	0.01	- 0.00	0.01	- 0.00	- 0.00	- 0.00	0.00	- 0.00	- 0.00	- 0.00	- 0.00
5	0.01	0.01	- 0.00	0.01	- 0.00	- 0.00	0.00	- 0.00	- 0.00	0.00	- 0.00	- 0.00
30	0.00	0.01	0.00	- 0.01	- 0.00	- 0.00	0.00	0.00	- 0.00	0.00	0.00	- 0.00
Real trade balance ^{b)}												
1	- 0.00	- 0.01	- 0.00	- 0.03	0.01	0.00	0.00	0.00	- 0.00	- 0.00	0.00	0.03
2	0.00	- 0.02	- 0.01	- 0.03	0.01	0.00	- 0.00	0.00	- 0.00	- 0.00	- 0.00	0.05
3	- 0.02	- 0.02	- 0.01	- 0.02	0.02	0.00	- 0.01	- 0.00	- 0.00	0.00	- 0.01	0.02
4	- 0.03	- 0.02	- 0.01	- 0.02	0.02	0.00	- 0.00	- 0.01	- 0.00	0.00	- 0.01	0.00
5	- 0.02	- 0.02	- 0.01	- 0.02	0.03	- 0.00	0.00	- 0.01	0.00	0.01	- 0.00	- 0.01
30	- 0.02	- 0.03	- 0.02	- 0.08	0.11	0.00	0.00	0.00	- 0.00	- 0.00	0.00	0.00

Notes: see Table 3

Table 4.6: Decomposition of transmission channels (scenario 2b)

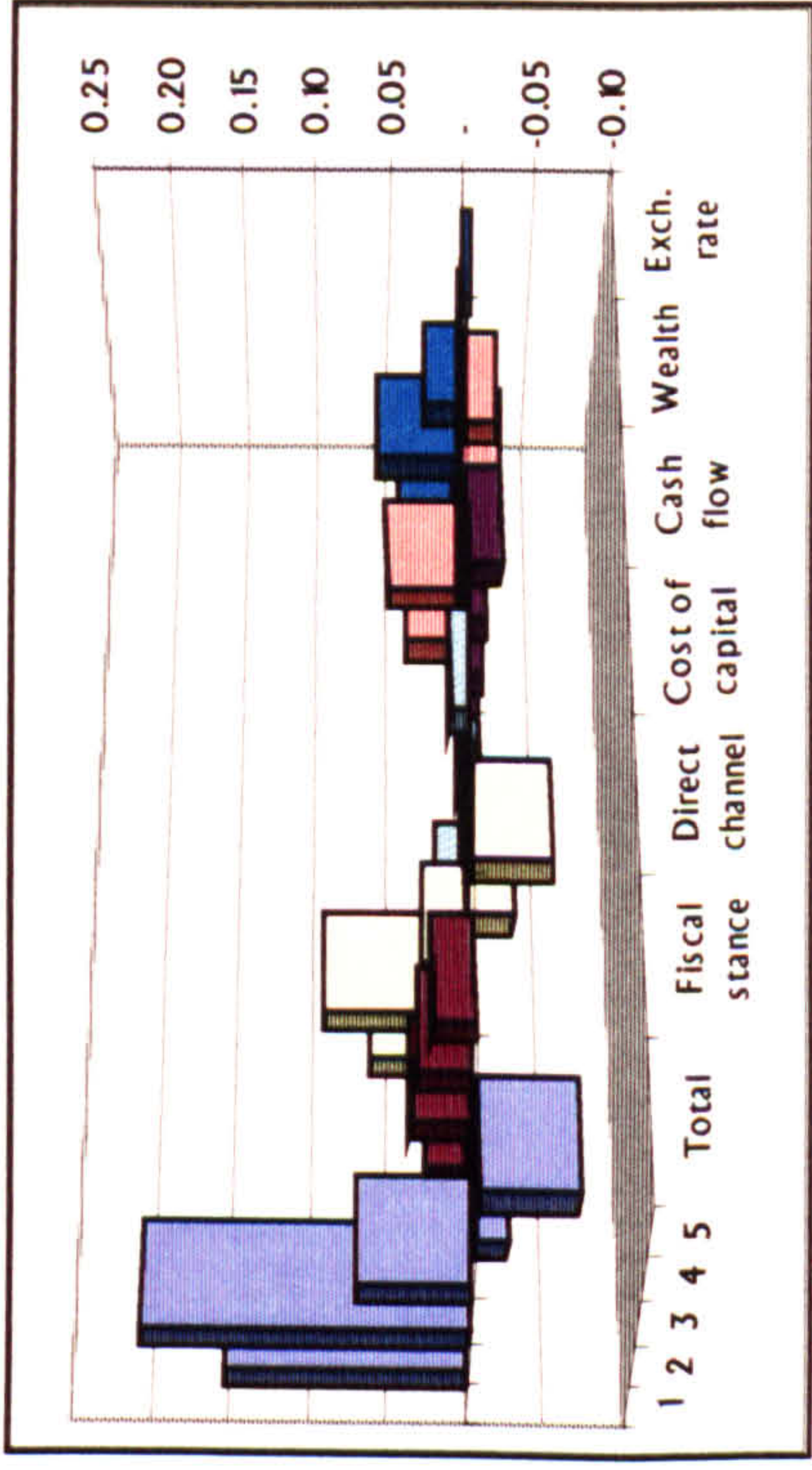
Scenario 2b. Fixed Exchange Rate Regime - (alternative consumption function)
Temporary Reduction of 1/2 Percentage Point in the Exogenous Component of Short-term Interest Rate

Year	Total	Fiscal stance	Direct channel	Cost of capital	Cash flow	Liquidity	Fin. assets	Credit	Mortgages	Housing	Wealth
GDP ^{b)}											
1	0.07	0.02	- 0.01	0.06	- 0.01	0.00	- 0.00	0.00	0.01	0.01	0.01
2	0.06	0.03	0.00	0.04	- 0.03	0.00	0.01	0.00	0.01	0.01	0.03
3	0.03	0.04	0.02	- 0.01	- 0.03	0.00	0.00	0.00	- 0.00	0.00	0.00
4	0.01	0.04	0.02	- 0.02	- 0.03	0.00	- 0.00	0.00	- 0.00	- 0.00	- 0.01
5	0.00	0.04	0.03	- 0.03	- 0.03	0.00	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00
30	- 0.00	0.00	- 0.01	0.01	- 0.00	- 0.00	0.00	- 0.00	0.00	0.00	0.00
Consumers' expenditure ^{b)}											
1	0.00	0.01	- 0.02	0.02	- 0.01	0.00	- 0.00	0.00	0.00	0.00	0.00
2	0.01	0.03	0.00	0.00	- 0.03	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	0.05	0.03	- 0.04	- 0.04	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.05	0.03	- 0.04	- 0.04	0.00	- 0.00	0.00	- 0.00	- 0.00	- 0.00
5	- 0.00	0.06	0.04	- 0.06	- 0.04	0.00	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00
30	- 0.01	0.07	- 0.08	0.01	- 0.01	- 0.00	0.00	0.00	- 0.00	- 0.00	0.00
Investment ^{b)}											
1	0.09	0.01	- 0.00	0.06	- 0.00	0.00	0.00	0.00	0.01	0.01	0.02
2	0.10	0.02	0.00	0.06	- 0.01	0.00	0.00	0.00	0.01	0.01	0.03
3	0.05	0.02	0.00	0.03	- 0.01	- 0.00	0.00	0.00	- 0.00	0.00	0.00
4	0.03	0.01	0.00	0.02	- 0.00	- 0.00	- 0.00	0.00	- 0.00	- 0.01	- 0.01
5	0.02	0.01	0.02	- 0.01	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00	- 0.00
30	0.00	0.00	0.04	- 0.04	0.00	0.00	0.00	- 0.00	0.00	0.00	0.00
Real trade balance ^{b)}											
1	- 0.04	- 0.01	- 0.00	- 0.03	0.01	0.00	0.00	- 0.00	- 0.01	- 0.00	- 0.01
2	- 0.05	- 0.02	- 0.00	- 0.02	0.01	0.00	- 0.00	- 0.00	- 0.01	- 0.01	- 0.01
3	- 0.03	- 0.03	- 0.00	- 0.01	0.01	0.00	- 0.01	- 0.00	- 0.00	- 0.00	- 0.01
4	- 0.03	- 0.03	- 0.00	0.00	0.01	0.00	- 0.01	- 0.00	- 0.00	0.00	- 0.00
5	- 0.02	- 0.03	- 0.00	0.01	0.02	0.00	- 0.00	0.00	0.00	0.00	0.00
30	0.00	- 0.08	0.04	0.03	0.01	- 0.00	0.00	0.00	- 0.00	- 0.00	0.00

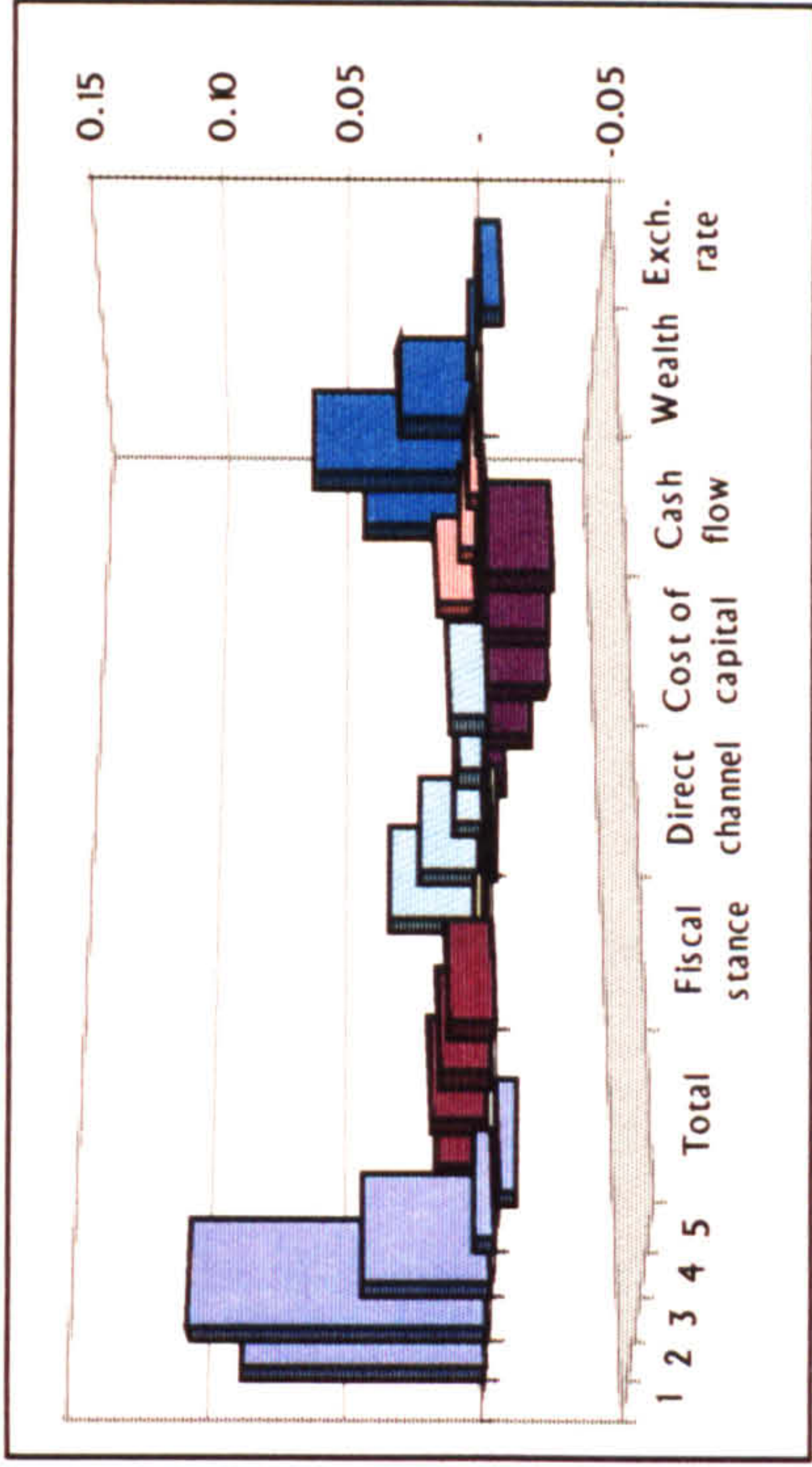
Notes: see Table 3

Figure 4.4: Contribution to GDP changes by transmission channel

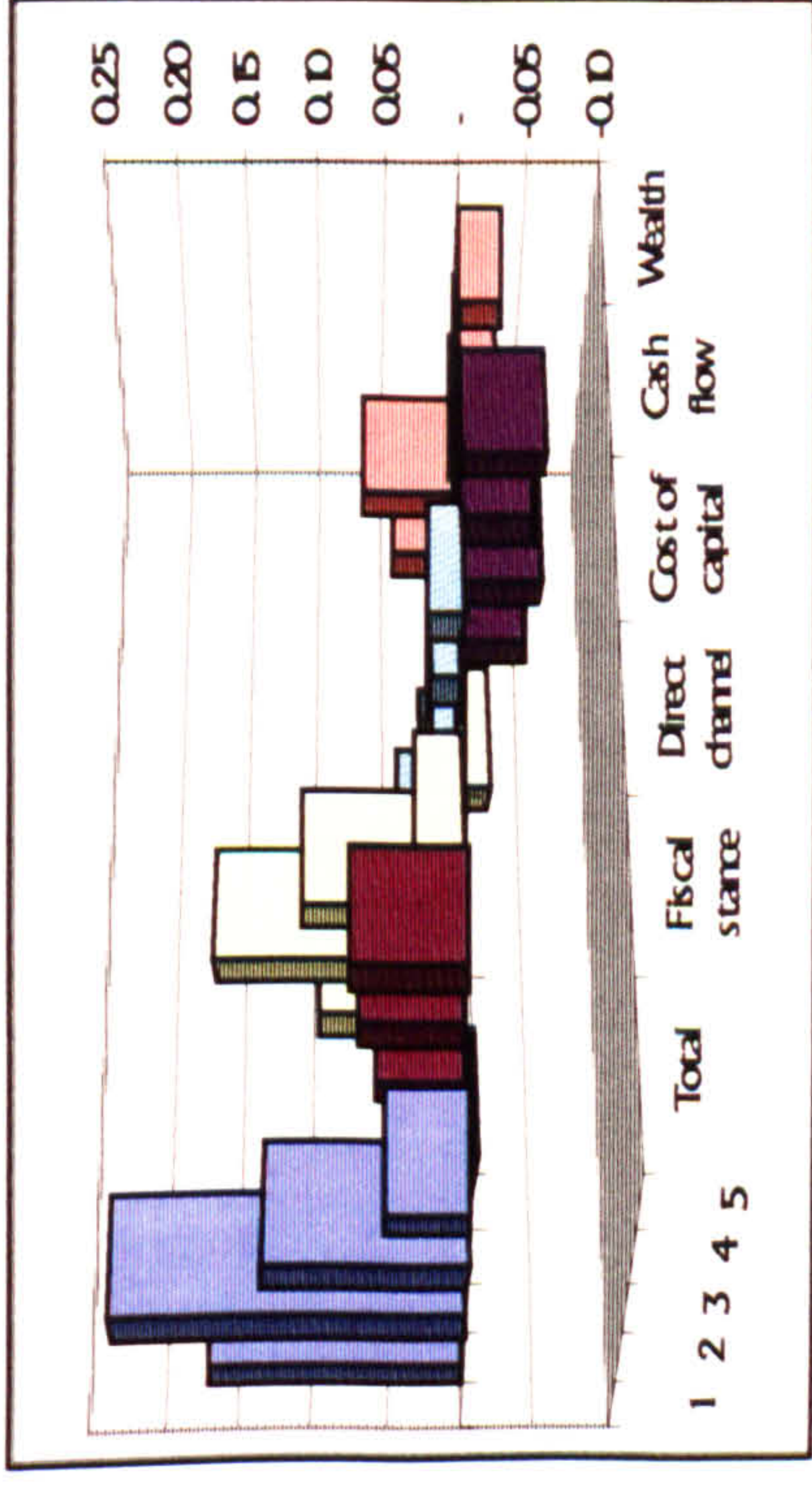
Scenario 1a



Scenario 1b



Scenario 2a



Scenario 2b

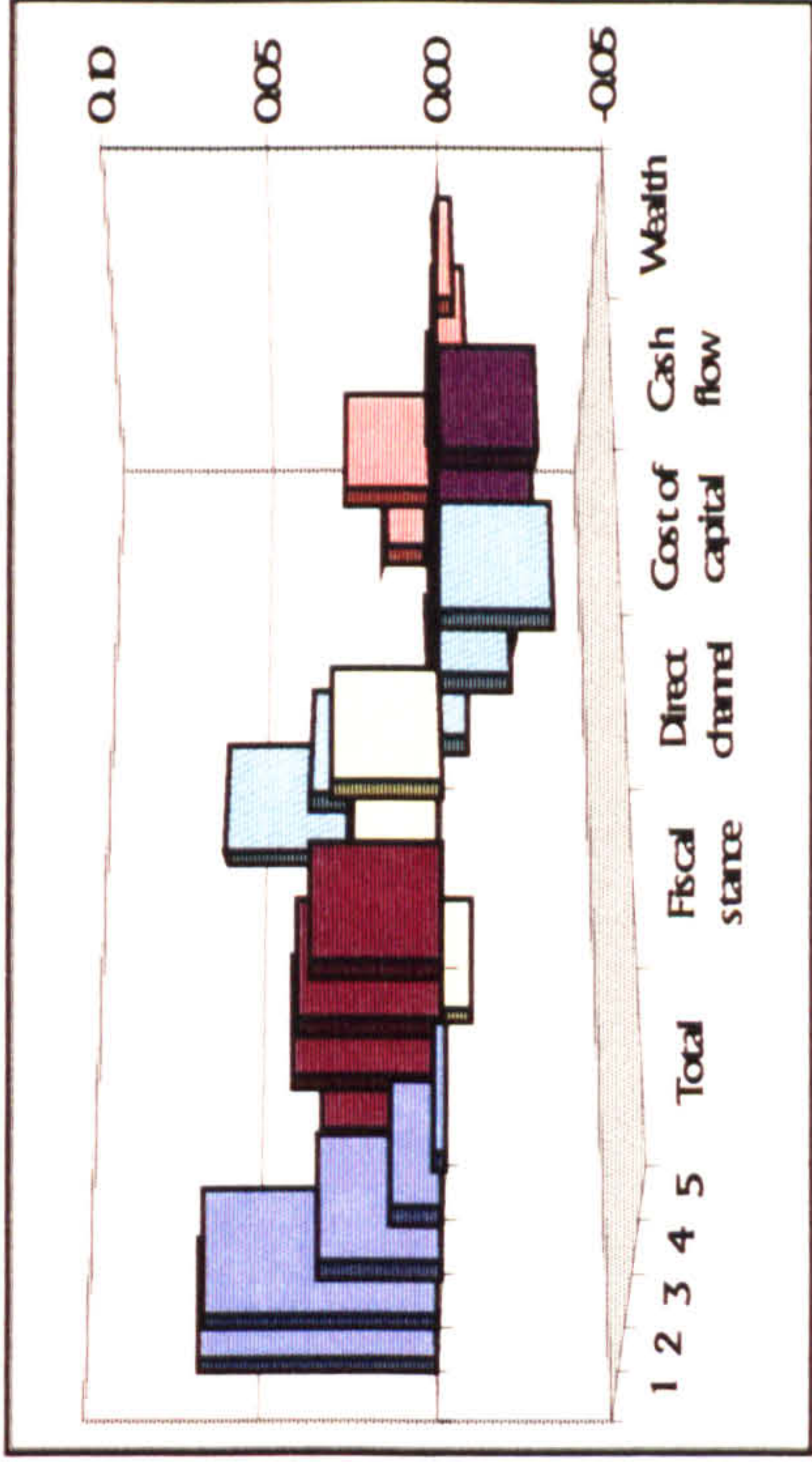
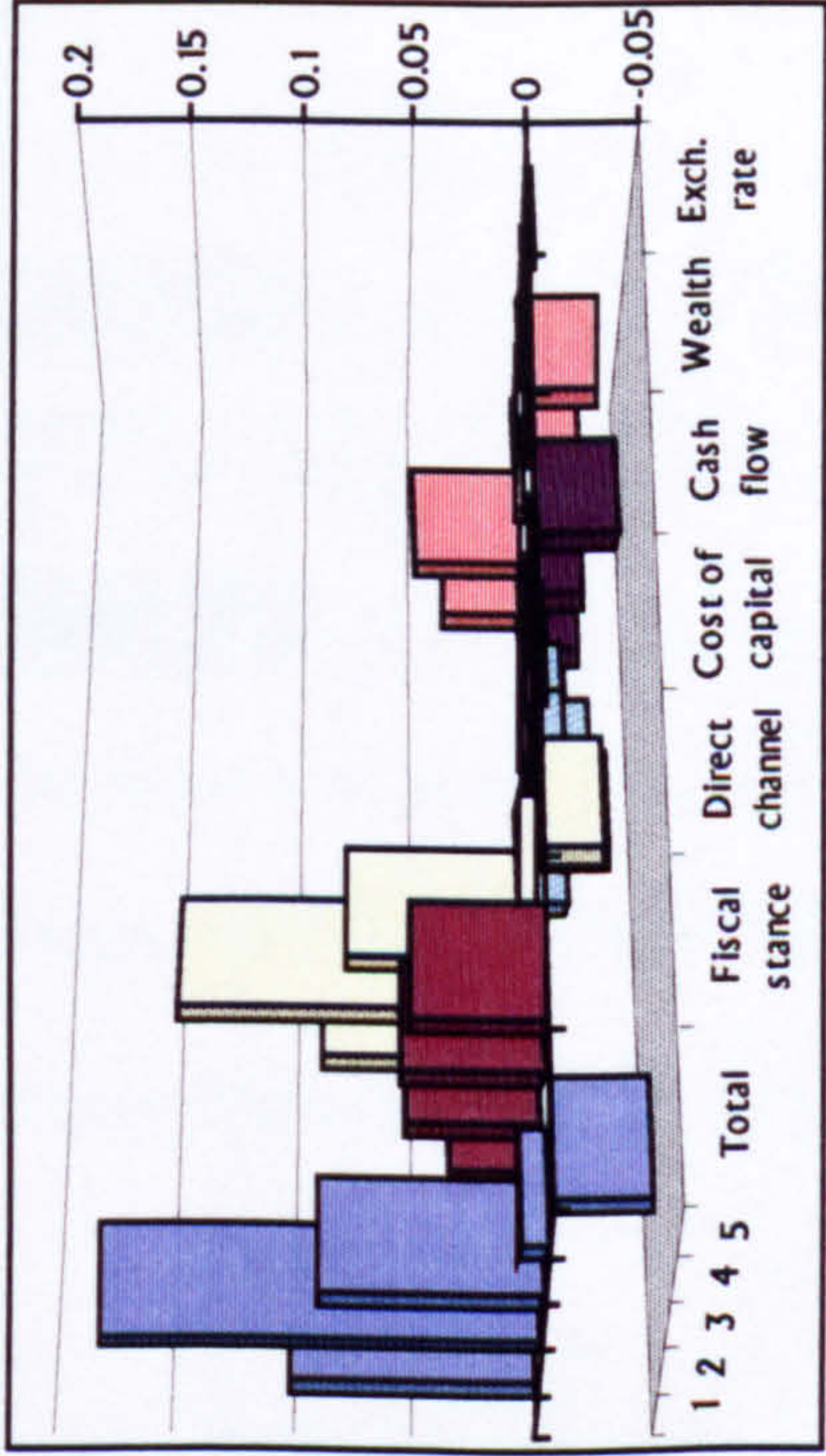
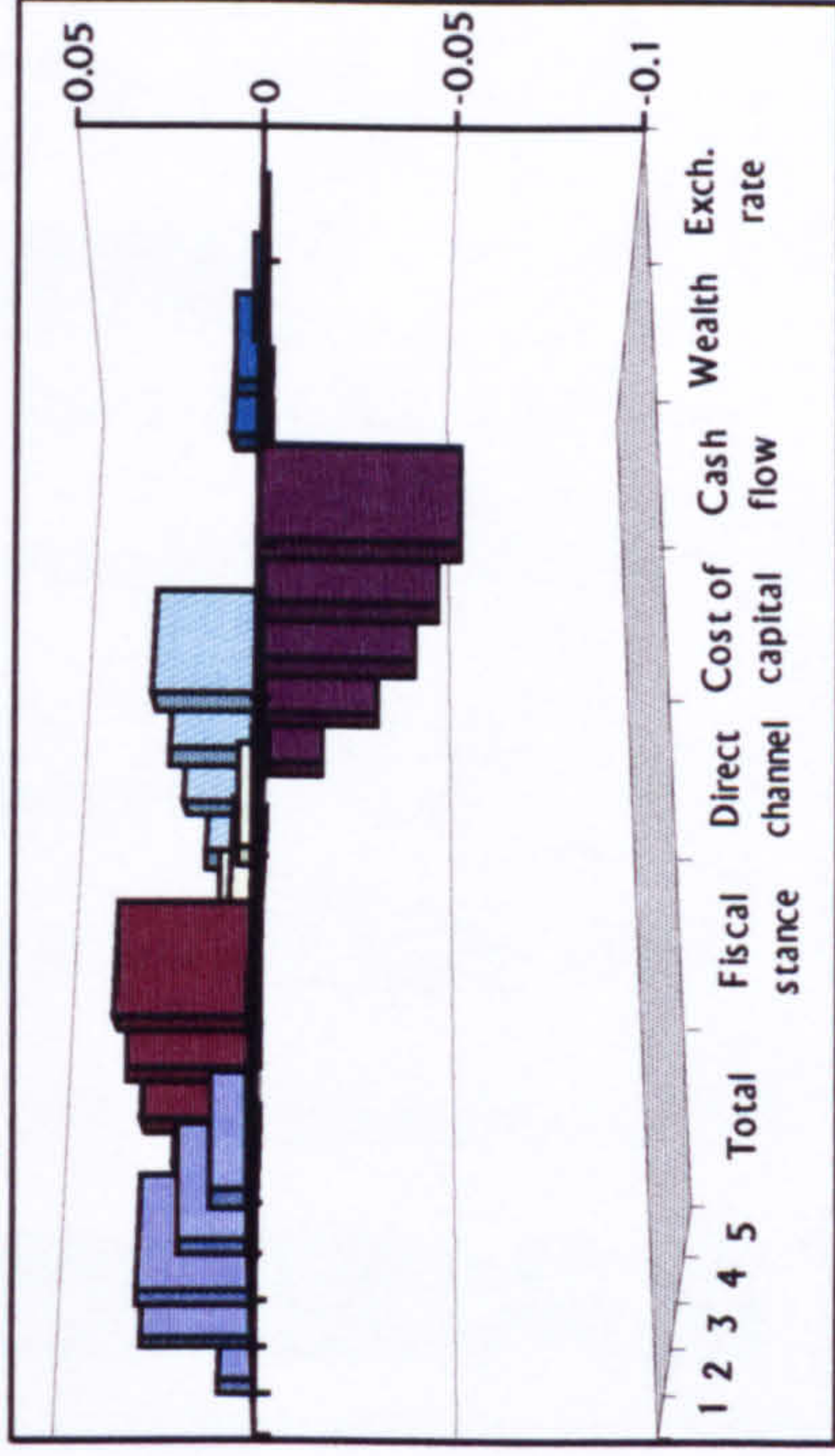


Figure 4.5: Contribution to consumption changes by transmission channel

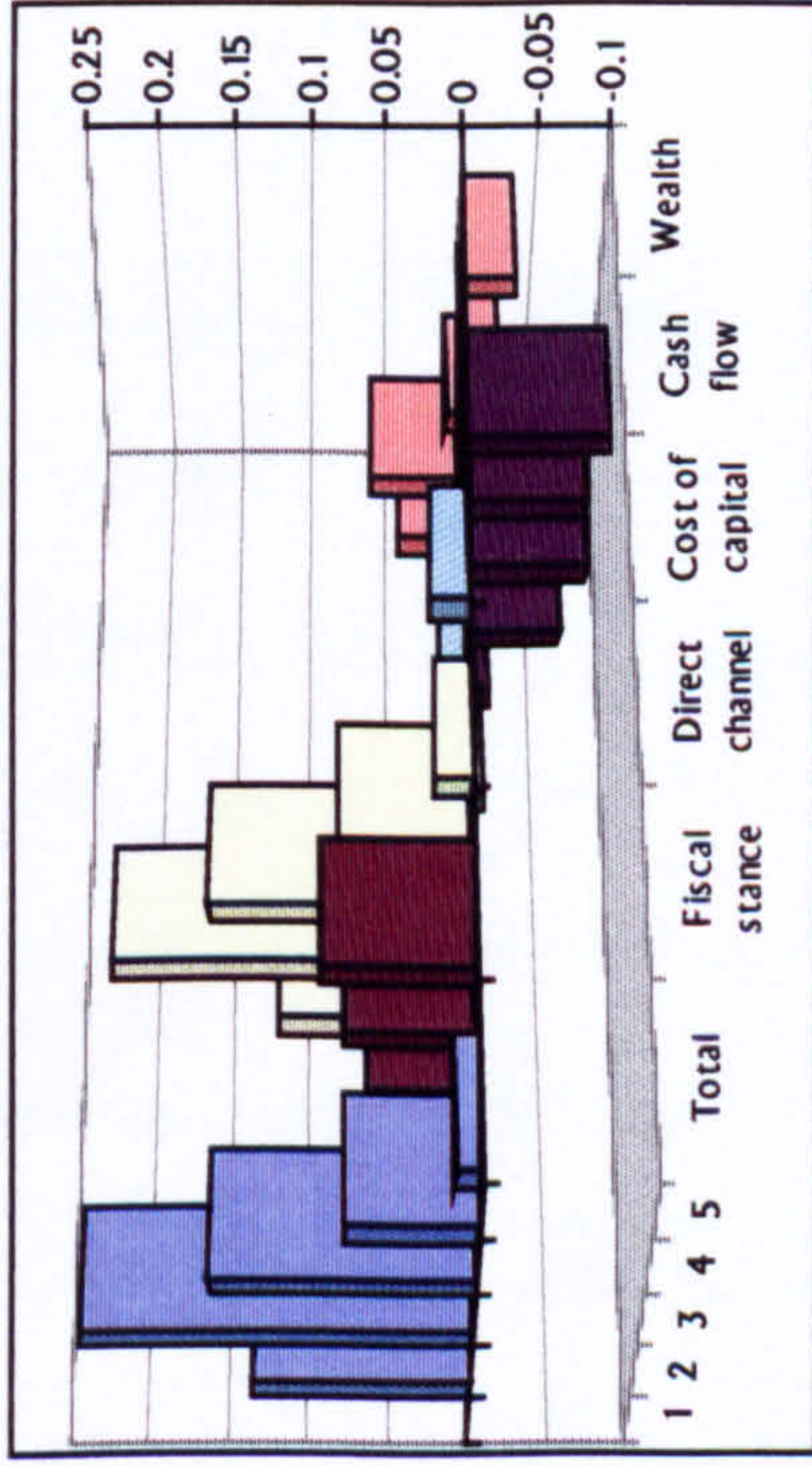
Scenario 1a



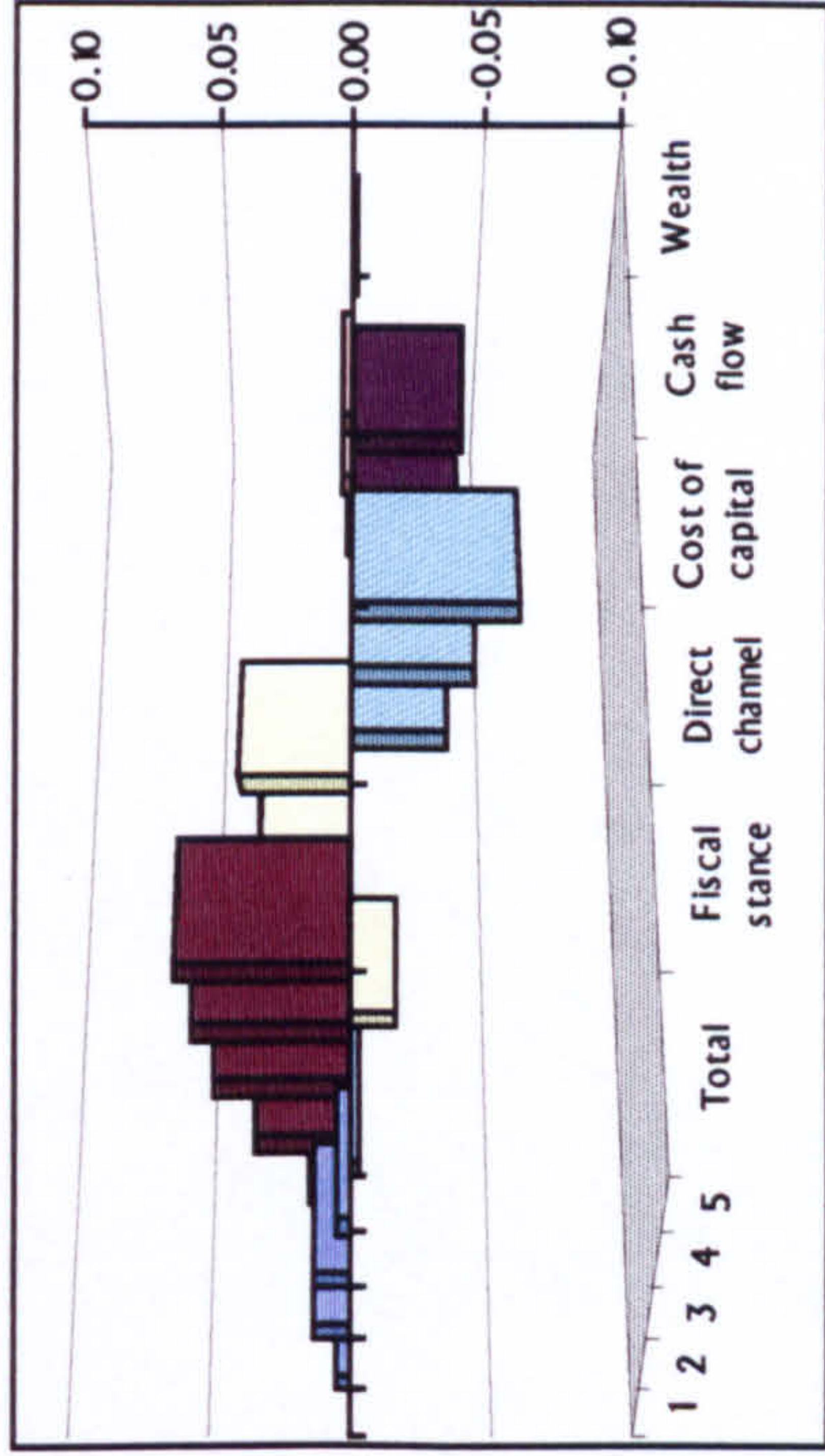
Scenario 1b



Scenario 2a



Scenario 2b



4.5 CONCLUSIONS

This chapter studies the characteristics of the UK monetary transmission mechanism, as portrayed by the National Institute's Domestic Econometric Model (NiDEM). UK real output and its spending components are found to be highly sensitive to monetary policy disturbances, in line with the findings of the BIS (1995). We argue, however, that the impact of interest rate movements on real variables is strictly determined by both the monetary regime at work and the underlying assumptions regarding consumption behaviour.

Under the model's default consumption specification, interest rate sensitivity increases when an inflation targeting rule is replaced by a pegged exchange rate regime. In both cases, however, it is the direct channel which transmits most of the policy change to the real economy, so that strong intertemporal substitution effects are a feature of British consumption behaviour. Wealth effects are also important, but this is only true during the first two years when the interest rate change is applied. This reflects the fact that mortgage debt and consumer credit respond vigorously to the short-term market rate rather than long rates.

The relevance of the fiscal transmission channel following a change in monetary policy is striking. We show that movements in the policy interest rate affect spending components strongly *via* its influence on the fiscal stance. In particular, the fiscal channel's contribution to the transmission of monetary shocks on to consumption under a fixed exchange rate regime is found to be one of the largest. Given the sluggish debt reabsorption present, its effect is not only limited to the short term but is likely to be more pronounced in the medium-to-long run. It should also be noted that given the decentralisation of fiscal policy and fiscal structures within EMU, evidence of a quantitatively important fiscal channel of monetary policy is likely to weaken the argument for a symmetric response to a common change in the policy rate.

Finally, the adoption of a life-cycle permanent-income consumption function containing human and non-human capital, liquidity constrained consumers and a future discount rate higher than the rate of interest, accounts for a smaller interest rate sensitivity of consumption under the standard scenario assumptions. In particular, intertemporal substitution effects are likely to be insignificant in this case.

Part Three

A Multi-Country Model

Chapter Five

The Fiscal Dimension of a Common Monetary Policy

5.1. INTRODUCTION

Since January 1999, eleven EU members have locked their currencies together, with the European Central Bank officially in charge of the short-term interest rate policy. The credibility problem involved in the sovereign choice of the output/inflation combination and the consequences of the fiscal stance in a context of international policy coordination have become recently hot topics in macroeconomics (for an overview, see Allsopp and Vines (1998) and the other articles on the same issue of the *Oxford Review of Economic Policy*). In fact, despite the monetary scenario facing joining EMU countries is one in which control of monetary policy is ceded to an independent central bank committed to price stability, fiscal decisions will remain essentially decentralised in the hands of eleven independent finance ministers - although in compliance with the requirements of the Stability and Growth Pact (SGP, henceforth). In the light of this, cooperative agreements *and* an appropriately designed

policy mix become the *sine qua non* for the success of EMU. The widespread consensus within EMU on the need for coordinated fiscal restraint seems indeed to be inspired by the recognition that fiscal discipline allows the credibility of monetary policy to strengthen. This, in turn, is judged to increase the likelihood of system-wide interest-rate cuts, certainly necessary to offset the country-specific costs of fiscal consolidation. Lax enforcement of the Excessive Deficit Procedure and Stability Pact is instead likely to bring greater pressure to bear on the central bank. Under these circumstances, the credibility of the latter's commitment to price stability would be greatly lessened (Alesina and Grilli, 1992).

However, despite the growing literature on the issue, no agreement seems to exist on the merits of enforcing international institutional arrangements such as the SGP. On the one hand, studies developed within a Keynesian framework tend to show that the current European institutional set-up, by assigning two distinct targets (price stability and real growth) to two distinct authorities (an independent Central Bank and (eleven!) independent national governments) each with only one instrument at hand (the nominal interest rate and fiscal deficits, respectively), creates unavoidable dichotomisation in the economy. The outcome will be a (i.e. eleven) suboptimal Nash equilibrium (equilibria) if compared with an alternative steady state in which monetary and fiscal authorities are in fact allowed to cooperate. In other words, everyone would be better off if monetary policy could actually accommodate to fiscal policy, that is with a Central Bank willing to give up part of its 'conservativeness'. According to this perspective, introduction of a SGP enforcing 3 percent deficit-to-GDP ratio ceilings imposes a further constraint to national fiscal authority, thereby threatening European economic growth and trapping the economy in a low-level equilibrium (Buiter, Corsetti and Roubini, 1993; Eichengreen and Wyplosz, 1998; Demertzis *et al.*, 1999).

On the other hand, models departing from the traditional IS/LM framework and assuming that transmission mechanisms of fiscal policy are different from those of the Keynesian multipliers, reach opposite conclusions. If fiscal effectiveness is rather the result of

distortions or non-neutralities affecting the economy, then the presence of excessive deficits will still be justified, in spite of the fact that they cease to represent a Pareto-optimal solution. In this way, the greater the degree of distortion in the economy, the more effective is fiscal policy, but also the lower will be the outcome in terms of social welfare. This kind of analytical framework, therefore, calls for a *deus ex-machina* able to remove inherent distortions and make everyone better off. The key question is then the source of the non-neutrality that features in the economy and provides the incentive to run deficits. Beetsma and Uhlig (1999), for example, analyse the requirement of a SGP among EU countries in the context of a multi-country political economy (see also Roubini and Sachs, 1989). As each national government is assumed to be run by a party having probability less than one to be re-elected in the next period, each fiscal authority fails to fully internalise the consequences of debt financing, given that debts are meant to be repaid in the next period. Such non-neutrality will create an inflation bias with real effects in a monetary union since the fiscal stance of one country will be reflected in changes in the real economy of the others via a gullible ECB. In this context there is, therefore, an incentive for the other member states to agree upon a SGP and enforce international fiscal responsibility. Detken (1999) addresses the case for a SGP within an overlapping generations model characterised by disconnected generations counting money and debt as net wealth. In this non-Ricardian closed economy, it is consumers who fail to internalise the consequences of future tax liabilities, thereby substituting future for current consumption in the face of higher stocks of debt. The argument in favour of a SGP is then that, as a 'conservative' ECB delivering a lower degree of monetary financing will in fact exacerbate Ricardian non-neutralities, an SGP will be needed 'as an intergenerational contract safeguarding the interest of future generations'.

In this chapter, we present an empirical analysis of the links between monetary and fiscal policy within EMU. This is done through simulation of a neo-classical highly non-Ricardian multi-country model: the IMF's MULTIMOD Mark III (MM3). In MM3 monetary policy has a quasi-fiscal dimension, since money both enters the government budget constraint and

affects real wealth. Each European economy is characterised - even in steady state - by a different debt/money composition of deficit financing and assumed to sustain it by running a different primary surplus. This allows us to assess the effects of a common monetary policy on country-specific fiscal stances as well as the implications of enforcing an institutional arrangement such as the Stability and Growth Pact for the Monetary Union itself.

Results suggest that indeed, in a global economy like the one described in MM3, the primary source of cross-country heterogeneity in response to a common monetary shock is the differences in national economies' budgetary positions. Centralising money supply seems to induce long-term cross-country wealth redistribution in response to a common monetary shock, unless accompanied by offsetting country-specific corrections in their debt stocks. Although the convergence criteria implicit in the Stability Pact are not necessary in MM3 to ensure fiscal sustainability, their strict enforcement is shown to be associated with overall ever-lasting benefits. Transition to the new steady state appears, however, remarkably costly for high-debt EMU countries. We also note that different degrees of rigidity in national labour markets crucially determine the size and speed of adjustments to a common monetary shock. On the contrary, different degrees of efficiency characterising European credit markets are *per se* unlikely to play a major role in explaining asymmetric responses.

The structure of the chapter is as follows. The next section describes the main features of the model. The baseline scenario and the design of the simulation experiments are illustrated in section 5.3, whereas the results are presented in section 5.4. Section 5.5 contains concluding remarks. In the appendix, main simulation results are discussed analytically.

5.2. MULTIMOD MARK III: MAIN FEATURES

To explore the implications of asymmetries in the transmission of monetary policy, we use the IMF's multi-country econometric model, MULTIMOD Mark III. In its basic version, it contains linked annual models for each of the G-7 economies plus three country blocks which aggregate the small industrial economies, the developing countries and the high-income oil-exporters, respectively. It is a general equilibrium macroeconomic model developed at the IMF to analyse the effects and the transmission of policy changes within and across countries. MM3 is in fact well suited for policy analysis, since its explicit characterisation of technology, household and firm preferences allows for parameter calibration to replicate certain stylised facts. Conversely, the model is not thought of as a tool for making unconditional forecasts. Rather, it takes the IMF's World Economic Outlook forecasts as the baseline for simulation scenarios. The structure and properties of MM3 are thoroughly described in Laxton *et al.* (1998), while its detailed documentation and codification can also be obtained at the IMF's external publications website (<http://www.imf.org>). The advantages of basing our research on this particular model are as follows.

MM3 is a forward-looking dynamic model whose simulation involves simultaneous solutions of both the dynamic system and its steady-state analogue counterpart. Solution of the steady-state model describes convergence to a balanced-growth path characterised by simultaneous stock and flow equilibrium. The steady-state model can thus be used both as an interpretative device and to determine model-consistent terminal conditions for dynamic analysis. Agents' behaviour is assumed to be purely forward-looking in asset markets (i.e. arbitrage condition and term structure equations) and partially forward-looking in goods markets, while being consistent with the Long-Run Natural Rate Hypothesis.

Striking in MM3 is the presence of a convex Phillips curve, which reflects short-run capacity constraints in such a way that, whereas inflation responds strongly to demand pressures under conditions of full employment, it is relatively insensitive to changes in activity in case of recessions. MM3 short-run inflation-output trade-off can be summarised by the system of equations reported below, where (5.1) describes the Okun's law translating output gaps $(y_t - \bar{y}_t)$ into unemployment gaps $(u_t - \bar{u}_t)$ and (5.2) specifies the short-run Phillips curve model. Corresponding country-specific parameter estimates are shown in table 5.1, limiting our attention to the four European economies.

$$(u_t - \bar{u}_t) = 100 \cdot \rho_1 (y_t - \bar{y}_t) + \rho_2 (u_{t-1} - \bar{u}_{t-1}) \quad (5.1)$$

$$\pi_t = \kappa [\delta_\pi \pi_{t+1}^e (1 - \delta_\pi) \pi_{t-1}] + (1 - \kappa) \pi_{t-1} + \frac{\gamma}{100} \frac{(u_t^* - u_t)}{(u_t - \phi_t)} + \varepsilon_t \quad (5.2)$$

Table 5.1: Okun's Law and Phillips Curve parameter estimates

	Germany	France	Italy	UK
ρ_1	-0.33	-0.30	-0.09	-0.33
ρ_2	0.18	0.44	0.79	0.69
κ	0.744	0.753	0.912	1
δ_π	0.53	1	1	0.53
γ	0.819	1.137	2.305	2.364
ϕ	4.521	5.104	5.676	2.248
u^*	8.521	9.104	9.676	6.248

Equation (5.1) can be regarded as a demand function for labour, with output demand taken as given. Partial adjustment entailed in ρ_2 implies that turnover is costly, so firms adjust employment slowly to changes in demand conditions. The expectations augmented Phillips curve (5.2) distinguishes between intrinsic dynamics and expectation formation (the term in square brackets). Namely, the model embodies fixed weights on forward- and backward-

looking components for inflation expectations (δ_π and $(1-\delta_\pi)$, respectively), which can however be modified to allow for alternative assumptions about expectations' formation and policy credibility. Moreover, the model reflects an overlapping contracting framework, according to which a proportion κ of workers negotiates nominal wage adjustments on the basis of expected future inflation, while remaining wage contracts are linked to lagged inflation. In this way, MM3 exhibits short-run Keynesian dynamics intended to capture inertial effects that are features of the inflation process. Finally, the non-linear term in unemployment can be derived from standard wage- and price-setting behaviours on the assumption that the degree of wage rigidity is a positive function of the actual level of unemployment, as it is implicit in labour market theories such as the 'efficiency wage' model. As a consequence of such non-linearity, the higher the rate of unemployment, the greater the degree of real rigidity that characterises the labour market (embedded in γ). *Ceteris paribus*, this will make the curve flatter and real responses to aggregate demand shocks larger, as shown for instance in Debelle and Laxton (1997). In an EMU context, the assumption of a non-linear Phillips curve implies that country-specific adjustments to a common shock hitting aggregate demand depend crucially on the relative initial position of the economy, not only on the parameter estimates of its short-run inflation-output trade-off.

Consumption-saving behaviour in MM3 is based on the Blanchard (1985) model in which agents are assumed to have finite planning horizons, extended to allow for age-dependent hump-shaped earning profiles and credit constraints. Within this framework, deficit financing and associated higher future tax burdens have important macroeconomic effects as private agents fail to fully internalise the implications of the government intertemporal budget constraint. Significant departures from Ricardian equivalence - in the form of consumers 'excessively' discounting future taxes or being 'excessively' sensitive to disposable income - result in fiscal policy having large effects on the real economy both in the short run and in steady state. A summary of the system of equations that make up the consumption model in MM3 is provided below.

$$C_t = C_t^{DI} + C_t^{PI} \quad (5.3)$$

$$C_t^{DI} = [\lambda_1 \beta_1 + \lambda_2 \beta_2 + \lambda_3 (1 - \beta_1 - \beta_2)] [Y_t - T_t] \quad (5.4)$$

$$C_t^{PI} = \theta \left[WK_t + \frac{NFA_t}{P_t} + \frac{B_t}{P_t} + \frac{M_t}{P_t} + (1 - \lambda) H_t \right] \quad (5.5)$$

$$(1 - \lambda) H_t = (1 - \lambda_1) \beta_1 H_{1,t} + (1 - \lambda_2) \beta_2 H_{2,t} + (1 - \lambda_3) (1 - \beta_1 - \beta_2) H_{3,t} \quad (5.6)$$

$$\dot{H}_{t,t+1} = (\alpha_t + p + rs_t + n) H_{t,t} - [Y_t - T_t] \quad (5.7)$$

where $\theta = f(\sigma^{-1}, p, n, rs_t)$ and $i = 1, 2, 3$.

Consumption is determined by the decisions of both permanent-income and disposable-income consumers (5.3). Credit constrained households choose their consumption based on current disposable income (C^{DI}). The parameters λ_i in (5.4) represent the proportions of households constrained by current disposable income at each stage of life (that is, youth, middle age and retirement). Excess sensitivity of consumption characterising current-income consumers thus depends on the relative share of aggregate disposable income accruing to this category of households over the entire life cycle, rather than simply on the proportion of liquidity constrained consumers in the population.

Unconstrained households make their decisions on the basis of permanent income (C^{PI}), which consists of financial wealth and human wealth (5.5). Financial wealth equals the sum of domestic equities (WK), net foreign assets (NFA), government bonds (B) and real balances (M/P). Human wealth (H), measuring the present discount value of future disposable labour income, is expressed by (5.6) as the sum of three components, reflecting the hump-shaped profile of individual's income over the three stages of his lifetime. The marginal propensity to consume, denoted by θ , is estimated as a function of the intertemporal elasticity of substitution (σ^{-1}) and subjective time preferences, under the assumption of constant relative

risk aversion utility (see Faruquee et al. (1997) for an exploration of the issue). The dynamics governing age-dependent human wealth (5.7) also reflect the concave profile of labour income over the life cycle. By introducing a further positive wedge (given by α_i) between the public rate (rs_i) and the private discount rate, beyond those resulting from finite planning horizons ($p>0$) and non-zero population growth (n), a consumption model embedding concave income profiles further enhances Ricardian non-neutralities. Namely, with disconnected generations, an increase in the fiscal deficit is not fully offset by an increase in private saving, as a share of debt burden falls on future generations whose current marginal propensity to save is zero. With life-cycle hump-shaped earnings and retirement, consumers further discount the impact of future tax liabilities, as the prospective tax base shifts to future generations with higher taxable income. In this way, the consequences of deficit financing in MM3 are clearly magnified.

Parameter estimates of the MM3's consumption model are reported in table 5.2, with respect to the four European economies. These are generally common values obtained by pooled regression technique for all G-7 countries. The coefficients characterising the concave earning profiles (α 's and β 's) are instead obtained by using data on labour income and employment by age cohort only for the US, and then imposed to be invariant across all industrial countries. The only exceptions are given by the country-specific estimates of the proportion of credit-constrained consumers in each age cohort. The effects of partially removing credit market imperfection within EMU-3 shall also be explored.

5.4. RESULTS

Results of a permanent 5 percent reduction in the EMU-3 money supply target on the main macroeconomic indicators for our four experiments are illustrated in Figures 5.1 to 5.5, with respect to the three major economies in the Euro area.

5.4.1. A common monetary policy

In Figure 5.1 we compare the macroeconomic effects of a 5 percent reduction in the aggregate target of monetary supply across the three major European economies. This simulation represents the benchmark for further experiments as it allows us to assess cross-country asymmetries in the interest rate transmission of a common monetary shock under standard assumptions and model specification.

As a result of an unanticipated and fully credible reduction on the EMU-3 money supply target, the initial money stock in the economy is judged to be excessive; an increase in the common interest rate is thus engineered to eventually restore equilibrium in the money market. While the common nominal interest rate rises by 1.4 percentage points in the first year, the corresponding fall in country-specific price level ranges between 0.5 and 1.5 percent, owing to the price stickiness characterising MM3. The forward-looking behaviour of the exchange rate yields an immediate appreciation of its nominal rate on the order of 6 percent, since the new target for money is fully credible and lower prices are to be expected in the future. The tightening of monetary conditions depresses aggregate demand and drives unemployment above its natural level. The combined effect of the slowdown in nominal GNP and higher nominal short-term interest rate worsen debt burdens. To meet intertemporal government constraints, tax rates are adjusted upwards so that disposable income falls, thereby inducing further reductions in current consumption. As prices and money adjust to the new target, interest rate moves back to base and

EMU-3 conversion rates

	Germany	France	Italy
DM	1	3.35	990
Euro	1.95583	6.55957	1936.27

Furthermore, to introduce an ECB in charge of a common monetary policy, we replace the German interest rate with a common rate driven by a reaction function containing the same parameters as the old German reaction function (i.e. with a feedback parameter on deviations from money target equals to 0.333 and zero weight on any other target), but with European level variables for money supply and target money supply. These are given by the sums of their three national counterparts. Hence, short-term interest rate adjusts to accommodate deviations of the European money stock from its supply target, according to the following monetary rule:

$$rs_t = rs_{t-1} - \frac{\omega}{\mu_2} \log \left[\frac{M_t^{EMU}}{(\bar{M}_t^{EMU})} \right] \quad (5.8)$$

where ω is the feedback parameter and μ_2 is the (identical) interest elasticity of money demand in each of the EMU-3 economies. Jointly estimated money demand equations relate the logarithm of real money balances to the logarithm of real domestic absorption and the short-term interest rate,

$$\log \left(\frac{M_t^i}{P_t^i} \right) = \mu_0^i + \mu_2 rs_t + \mu_4 \log \left(\frac{M_{t-1}^i}{P_{t-1}^i} \right) + (1 - \mu_4) \log (C_t^i + I_t^i + G_t^i) + \varepsilon_t \quad (5.9)$$

with $\mu_2 = -0.0054$ and $\mu_4 = 0.789$ for all industrial countries¹. Conversely, μ_0 differs across

**PAGE
NUMBERING
AS ORIGINAL**

economies so that, in steady-state, domestic stocks of money as proportion of nominal GNP are consistent with national governments budgetary stances, under preassigned money growth and nominal interest rate.

National fiscal stances are governed in MM3 by identical reaction functions with imposed parameters. Specifying fiscal closure rules enforcing government's intertemporal budget constraint is nowadays commonly recognised as an essential requirement in large-scale models (Mitchell *et al.*, 2000). Their inclusion is intended to preclude the possibility of explosive solutions in which debt grows boundless as proportion of nominal GNP, thereby ensuring consistency of the theoretical structure of the model in the long run. Moreover, if rational expectations are incorporated, as it is in MM3, then sensible long-run properties are necessary to warrant also a plausible short-run behaviour (Mitchell *et al.*, 2000). MM3 is characterised by the following moving-average forward-looking tax rules:

$$t_t = \frac{1}{5} \sum_{i=-2}^2 t_{t+i} + \tau(b - \bar{b})_{t+1} \quad (5.10)$$

where t_t is the average tax rate, τ is the feedback parameter, identically equal to 0.2, b denotes country-specific debt-to-GNP ratios and \bar{b} the corresponding desired path. The target value for any debt ratio is throughout assumed to be consistent with its steady-state value. It should be noticed that such forward-looking moving average tax rule has the interesting feature of accommodating both past and future expected deviations of debt ratios from target. This seems to extend the conceptual framework traditionally characterising monetary policy to fiscal policy. Such assumption does not reflect a complete lack of realism (The Economist, 1999). However, given that MM3 features a contemporaneous monetary reaction function, this implies that fiscal authority moves first, while central bank is forced to take action to achieve its target. The matter is likely to be crucial to assess the short-run responses to permanent shocks to budget deficit.

The first step to shed light on the fiscal dimension of monetary policy within EMU, is understanding the long-run implications of public deficit financing. Let us consider the system

of equations comprising the tax rule (5.10), the intertemporal government budget constraint (5.11) and the definitional identity for deficit financing (5.12):

$$D_t = r_t B_{t-1} + (G_t - T_t) \quad (5.11)$$

$$D_t = \Delta B_t + \Delta M_t \quad (5.12)$$

where D_t denotes public deficit and $(G_t - T_t)$ is the primary deficit (all the variables are expressed in nominal terms). Public deficit can be financed either by issuing new bonds (ΔB_t) or by printing money (ΔM_t). In MM3, money growth is uniquely determined by country-specific changes in money demand. We will initially simulate an EMU-3 under such assumption. Later, we will consider the case where money creation is centralised in the hands of the ECB, and money growth reflects changes in the European aggregate.

The stability properties of the two-equation system (5.10)-(5.11) can be described by the implied fifth-order difference equations for t_{t+2} for each of the three countries. In all the cases, stability is ensured by the existence of two roots lying inside the unit circle; the existence of a complex conjugate pair outside the unit circle implies that adjustment trajectories for debt ratios are overall characterised by damped oscillations. However, because money stocks and primary surplus ratios to nominal GNP differ in equilibrium across the EMU-3 countries, their dynamics are correspondingly dissimilar, with Germany exhibiting the largest fluctuations as its roots get closer to the unit circle. To derive mutually consistent steady-state values for debt, primary surplus and money stock ratios in each country, we use the long-run solution of the system (5.11)-(5.12). This is given by:

$$\frac{B+M}{PY} \left[1 - \frac{1}{\bar{\pi} \bar{g}} \right] = \frac{B}{PY} \left[\frac{\bar{r}}{\bar{\pi} \bar{g}} \right] + \frac{(G-T)}{PY} \quad (5.13)$$

where \bar{r} is the steady-state nominal rate on government bonds, $\bar{\pi}$ denotes steady-state inflation and \bar{g} is the corresponding real growth rate, so $\bar{\pi} \bar{g}$ yields equilibrium money growth. Results

are summarised in table 5.3. It should be noticed, first, that the equilibrium budgetary stances are presumed to differ significantly across the EMU countries.

Second, and more strikingly, MM3 assumes that a country like Italy will never be able to meet Maastricht requirements, by *permanently* running a deficit in excess of 3 percent of GNP and maintaining a debt-to-GNP ratio above 89 percent. It is worth noticing that this is indeed a perfectly sustainable fiscal policy, under the assumption that the country is able to run a permanent primary surplus of 1.73 percent and given the steady-state parameterisation of the model. However, its implications for the conduct of a common monetary policy are unlikely to be negligible. We can in fact show that, without a strict surveillance of medium-term fiscal positions, differences in the transmission of a common monetary shock across the Euro area can be seriously large, thereby undermining the stability of the Monetary Union itself.

Table 5.3: Country-specific steady-state budgetary positions

	Germany	France	Italy	UK
Debt	32.7	42.2	89.3	30.3
Money	9.27	3.96	9.62	3.90
Deficit	1.98	2.18	4.68	1.62
Primary surplus	0.363	0.846	1.73	0.558
Total taxes	20.9	21.6	19.1	20.9
Government spending	20.6	20.7	17.4	20.4

Values are expressed as percentage to nominal GNP

5.3. THE SIMULATION EXPERIMENT

5.3.1. The baseline scenario

Table 5.4 shows the baseline forecast for a set of key macroeconomic variables for the four European countries belonging to the G-7 group, based on projections in the IMF's annual report World Economic Outlook for 1998. Precisely, projections run forward 21 years from 1999. Those over the next 4 years are shown in the second panel of the table. The last column shows medium-to-long term projections that can be interpreted as abstracting from effects of business cycle variations and, in MM3, these reflect the steady-state levels or growth rates of the relevant variables. Since the aim of our chapter is to identify asymmetric transmissions within EMU owing to country-specific differences in the *structure* of their economy, rather than to their initial *position* in the business cycle, we decided to simulate the model starting from 2020, that is from an equilibrium position. The model is further solved sufficiently far ahead, to 2100, so as to remove any influence of the terminal conditions on our simulation results. For model-consistent expectation variables are solved to be equal to the projected outcome for the relevant horizon, the World Economic Outlook baseline defines our conditioning information set.

In 1998, growth in the Euro area has been weak (averaging 2.64 percent) and unemployment has continued the trend rise that started in the 1970s (peaking at 11.8 percent). In particular, in Germany the need for fiscal consolidation after the heavy costs of unification has played a major role in slowing recovery, although this is thought to gain strength, reaching its peak of 3.1 percent in year 2000. In France, growth performance looks more vigorous than in Germany and Italy for two main reasons. First, the degree of fiscal consolidation in France has been less than in the other countries over the 1990s. Second, labour market policies have been more effective, thereby boosting France's competitiveness within the Euro area and expected to reduce unemployment by about 2.9% over the period 1998-2002. Economic growth in Italy has been the weakest among Europe's major economies at the end of the 1990s, in part reflecting the

particularly tight fiscal policies that have been needed. Perspective entry to EMU is assumed to reduce both inflation and short-term interest rate by 0.3 percentage points by 2002. Outside the Euro area, UK seems to experience higher inflation rates (on the order of 2.7 percent in 1998) while keeping unemployment at outstandingly low levels (5 percent). This certainly reflects the lower NAIRU and the higher degree of flexibility characterising UK labour market compared with the rest of Europe (see also table 5.1).

With respect to the medium-term forecasts, potential output growth rates are assumed to be on the order of 2.2 percent in all the G-7 countries. Inflation is assumed to stabilise at 2.7 percent in the whole industrialised world. As a result, money grows in steady state at an annual rate of 4.96 percent. The equilibrium real short-term interest rate is 5.34 percent, while the corresponding long-run rate is assumed to be 103 basis points lower. The steady-state real rate on government bonds is given by the average of short- and long-term rates (that is 4.83 percent).

Such steady-state values represent the information set upon which our simulation experiments will be conditioned. This implies that our assessment of fiscal policy sustainability, just to mention one example, that is our derivation of equilibrium national budgetary stances according to (5.13), is constructed on the implicit assumption that these values are given and never believed to change.

Table 5.4: MM3 baseline forecasts

	1998	1999	Forecasts			Steady state
			2000	2001	2002	
Germany						
Inflation rate	1.55	1.70	1.70	1.74	1.70	2.7
Real growth	2.79	2.98	3.10	2.78	2.49	2.2
Money growth	4.42	4.73	4.85	4.55	4.96	4.96
Short-term interest rate	3.8	4.7	5.1	5.1	5.1	8.04
Long-term interest rate	6.2	6.3	6.4	6.4	6.4	7.01
Unemployment rate	11.16	10.55	9.95	9.42	8.92	8.52
France						
Inflation rate	1.17	1.80	1.80	1.80	1.80	2.7
Real growth	2.89	3.07	3.18	3.19	3.19	2.2
Money growth	3.98	4.80	4.93	4.94	4.96	4.96
Short-term interest rate	3.98	4.85	5.3	5.3	5.3	8.04
Long-term interest rate	6.1	6.2	6.3	6.3	6.3	7.01
Unemployment rate	12.30	11.59	10.87	10.16	9.43	9.10
Italy						
Inflation rate	2.30	2.00	2.00	2.00	2.00	2.7
Real growth	2.25	3.05	3.11	2.90	2.74	2.2
Money growth	4.41	4.90	5.00	4.82	4.96	4.96
Short-term interest rate	6	5.7	5.7	5.7	5.7	8.04
Long-term interest rate	6.8	6.8	6.8	6.8	6.8	7.01
Unemployment rate	11.94	11.65	11.06	10.46	9.74	9.68
United Kingdom						
Inflation rate	2.71	2.52	2.55	2.57	2.58	2.7
Real growth	2.50	2.34	2.23	2.18	2.14	2.2
Money growth	5.39	4.97	5.00	4.98	4.96	4.96
Short-term interest rate	7	7	7	6.5	6.5	8.04
Long-term interest rate	7.1	7.1	7.1	7.1	7.1	7.01
Unemployment rate	5.04	5	5	5	5	6.25

^(*) Values are expressed in percentage points

5.3.2. The design

The aim of our analysis is primarily to show that differences in national economies' budgetary positions can generate significant asymmetries in the transmission of a common monetary shock in the context of an Economic and Monetary Union among Germany, France and Italy. In the light of this we simulate a permanent 5 percent reduction in the EMU-3 money supply target, under the assumption that a fully independent ECB is adjusting short-term policy rate to reduce aggregate money supply to the new target. In the face of a permanent and fully credible *deflationary* shock, the money Euro aggregate in equilibrium decreases by 5% with prices adjusting one for one with the reduction in money supply (for theoretical analysis see Ball, 1994). This experiment represents our benchmark scenario. It permits us only to evaluate the relevance of cross-country asynchronies in adjustments to a common monetary shock. Under these circumstances, asymmetries are almost entirely driven by dissimilarities in the structure of national labour markets, which is reflected in the model by country-specific parameterisation of short-run inflation-output relationships. To show that, in a world where bonds and money are counted as net wealth, the primary source of cross-country heterogeneity in response to a common monetary shock is the differences in national economies' budgetary positions, we must repeat the same experiment under sensible alternative assumptions, namely:

- a common rate of money financing across the three countries, as a result of the centralisation of seigniorage revenues under EMU;
- a strict enforcement of the SGP, ensuring that Maastricht criteria will be met by all European countries, at least in steady state;
- more efficient credit markets all over the Euro area.

Contrary to country-specific adjustments to an interest-rate transmitted monetary shock, wealth effects are likely to be ever-lasting, as they reflect dissimilarities in national fiscal stances which are expected to be maintained in equilibrium. Given that static homogeneity is an inherent

feature of MM3, any evidence of long-run real effects following a permanent reduction in money supply is then to be associated with the so-called ‘fiscal dimension’ of monetary policy. Repeating the deflation experiment under the above-mentioned alternative scenarios will thus allow us to determine (i) the sources of asymmetric adjustments to a common monetary shock, (ii) the transmission channels operating in each case, (iii) the relative magnitude of short- and long-term responses across European countries.

5.4. RESULTS

Results of a permanent 5 percent reduction in the EMU-3 money supply target on the main macroeconomic indicators for our four experiments are illustrated in Figures 5.1 to 5.5, with respect to the three major economies in the Euro area.

5.4.1. A common monetary policy

In Figure 5.1 we compare the macroeconomic effects of a 5 percent reduction in the aggregate target of monetary supply across the three major European economies. This simulation represents the benchmark for further experiments as it allows us to assess cross-country asymmetries in the interest rate transmission of a common monetary shock under standard assumptions and model specification.

As a result of an unanticipated and fully credible reduction on the EMU-3 money supply target, the initial money stock in the economy is judged to be excessive; an increase in the common interest rate is thus engineered to eventually restore equilibrium in the money market. While the common nominal interest rate rises by 1.4 percentage points in the first year, the corresponding fall in country-specific price level ranges between 0.5 and 1.5 percent, owing to the price stickiness characterising MM3. The forward-looking behaviour of the exchange rate yields an immediate appreciation of its nominal rate on the order of 6 percent, since the new target for money is fully credible and lower prices are to be expected in the future. The tightening of monetary conditions depresses aggregate demand and drives unemployment above its natural level. The combined effect of the slowdown in nominal GNP and higher nominal short-term interest rate worsen debt burdens. To meet intertemporal government constraints, tax rates are adjusted upwards so that disposable income falls, thereby inducing further reductions in current consumption. As prices and money adjust to the new target, interest rate moves back to base and

recession starts being reabsorbed. In the long run, prices are 5 percent below base whereas nominal exchange rate is 5 percent higher. Inflation and real variables move back to their pre-shock values.

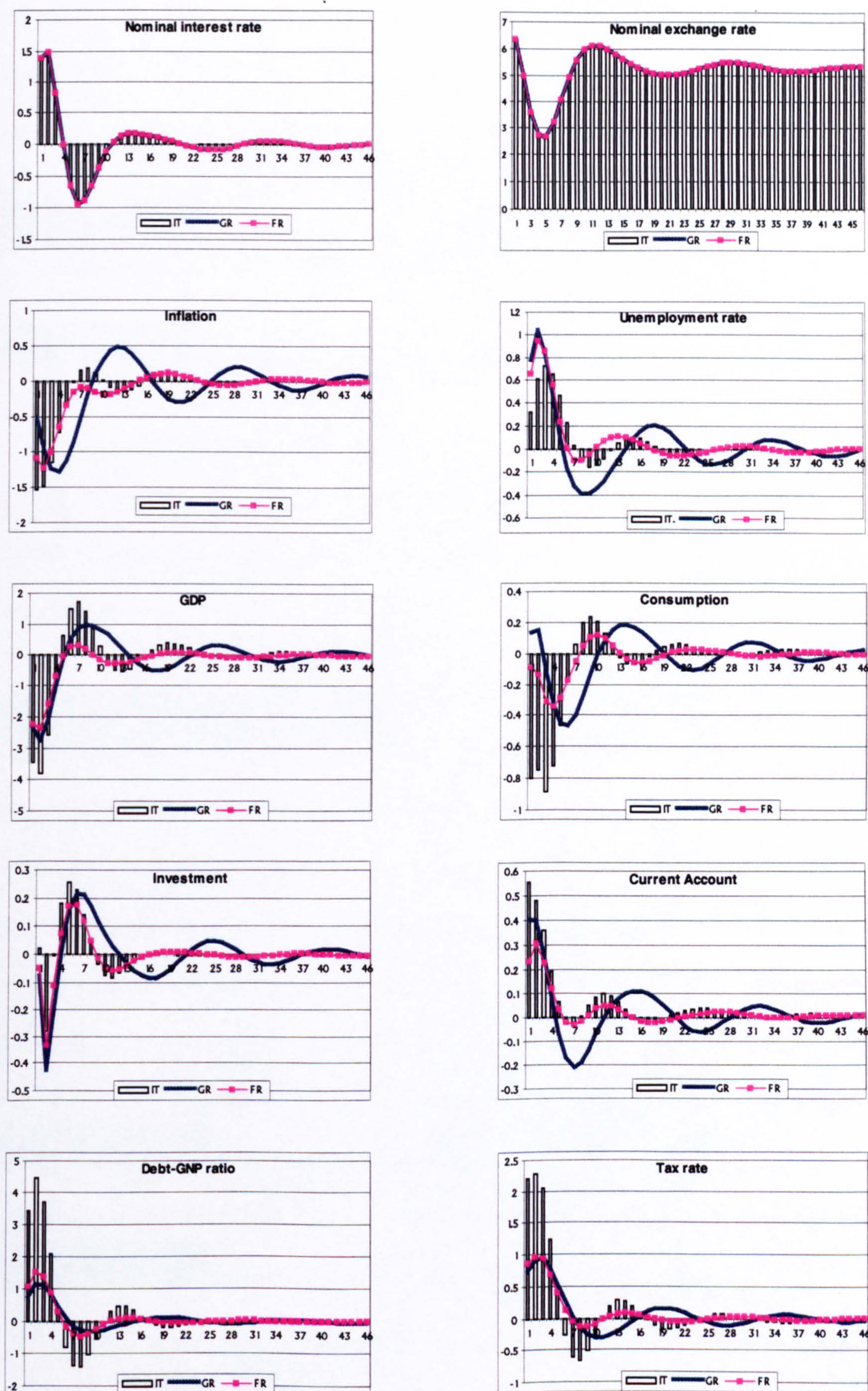
Though such adjustment process characterises all EMU-3 economies, responses to a common monetary shock differ across countries with respect to both size and persistence. Differences in the amplitude of responses are primarily due to:

- (a) differences in the degree of nominal and real rigidity in national labour markets, determining the extent to which inflation responds to its own future expected changes and demand conditions in each economy;
- (b) differences in national debt stocks, as debt burdens will be proportionally boosted in the face of an identical increase in the nominal interest rate.

Let first focus on Italian adjustments, as they seem to differ substantially from those of the other EU countries considered. Prices are by far less sticky, with an immediate fall by 1.5 percent on announcement of the new monetary target. This is explained, in part, by the high degree of nominal flexibility characterising its short-run expectations augmented Phillips curve (given by the estimate of κ in equation (5.2) reported in table 5.1), and in part by the assumption, embedded in δ_m , that the Italian labour market consists only of rational agents (or, equally, that there exists an immediate learning about future price inflation). As prices fall sharply, the real value of Italian public debt stock boosts. The higher (nominal) debt service induced by the endogenous increase in common interest rate will move further upwards the debt ratio in proportion to baseline GNP. As a fact, the corresponding Italian response is about three times as large as in the other EU countries in the face of a common shock. Analogously, the adjustment in the average tax rate needed in Italy to ensure long-run fiscal policy sustainability is about 2.2 percentage points, while a mere 0.8 percentage-point increase is sufficient to guarantee the same result in the other EMU-3 economies. As the fiscal closure rule is forward-looking, current tax rates overreact to accommodate both current and future deviations of the debt ratio from target.

Given the strong presence of liquidity constrained households featuring the model, consumption is extremely sensitive to changes in disposable income. In this way, effects of a common monetary shock on consumption and, thereby, on GNP components, appear to be significantly larger for Italy than for any other country of the Euro area. Interestingly, such large swings in real output are not reflected in correspondingly larger fluctuations in Italian unemployment. This can be explained by the fact that the parameter estimate on the output gap (ρ_1) in the Okun's law (5.1) is remarkably low for Italy. This is likely to shelter labour market conditions from the consistent fall of real output from potential following the monetary shock.

As far as Germany and France are concerned, asymmetries in the transmission of a common shock are much less noticeable, as their debt stocks in proportion to GNP are on the same order of magnitude (32.7 and 42.2 percent, respectively) and substantially lower than the Italian debt ratio. Nonetheless, for Germany, where significant real and nominal rigidities characterise the short-run inflation-output relationship (compare γ and κ in table 5.1), changes in aggregate demand show more persistent effects on real economic activity and unemployment than in any other European country. A slightly slower debt reabsorption can also be observed in Germany, owing to the intrinsic dynamics characterising its fiscal side (recall section I).

Figure 5.1: Deflation experiment within EMU-3 - Reducing aggregate money target by 5%

Note: Deviations relative to baseline are expressed in percentage for nominal exchange rate and GNP and in percentage points in any other case. Consumption, investment and current account balance are expressed as difference in proportion to baseline nominal GNP.

5.4.2. A common degree of debt monetisation

Under the default scenario, changes in money financing of national government deficits correspond to country-specific changes in money demand. However, as money creation under EMU is centralised in the hands of the ECB, variations in the degree of money financing should rather reflect changes in the European money aggregate. For each of the three EMU economies considered here we, hence, replace (5.12) with:

$$D_t^j = \Delta B_t^j + \Delta M_t^{EMU} \frac{(PY)_t^j}{\sum_j (PY)_t^j}. \quad (5.14)$$

The last term on the RHS of (5.14) represents the weight of country j 's nominal GNP on the European aggregate and is required to ensure consistency with MM3 terminal conditions for money growth.

What distinguishes this scenario from the previous one is the fiscal dimension of the common monetary shock which is transmitted to national economies *via* changes in their degree of debt monetisation. Under the previous scenario, money balances only adjusted endogenously in response to changes in the common interest rate. However, their pre-shock equilibrium levels were eventually restored as money is neutral in MM3. Here we assume that changes in the monetary aggregate have a direct impact on the fiscal stance, inasmuch as they are mirrored by variations in the degree of money financing. Under these circumstances, a permanent shock to the EMU-3 money target may turn into a *permanent* shock to national fiscal deficits, *if* having common money supply happens to alter country-specific seigniorage revenues in equilibrium. This is always true if the steady-state for (the inverse of) money velocity is allowed to vary across countries. In fact, within EMU, where

$M^{EMU} = \sum_j M_j$ holds, the corresponding new equilibria for seigniorage revenues in proportion of GNP will be given by $\frac{\Delta M^{EMU}}{M^{EMU}} \frac{M^{EMU}}{\sum_j P_j Y_j}$ rather than by country-specific

values $\frac{\Delta M_j}{M_j} \frac{M_j}{P_j Y_j}$. It follows that, under EMU, country-specific steady-state fiscal stances must also change, as shown by the modified long-run solution of the system (5.11)-(5.14):

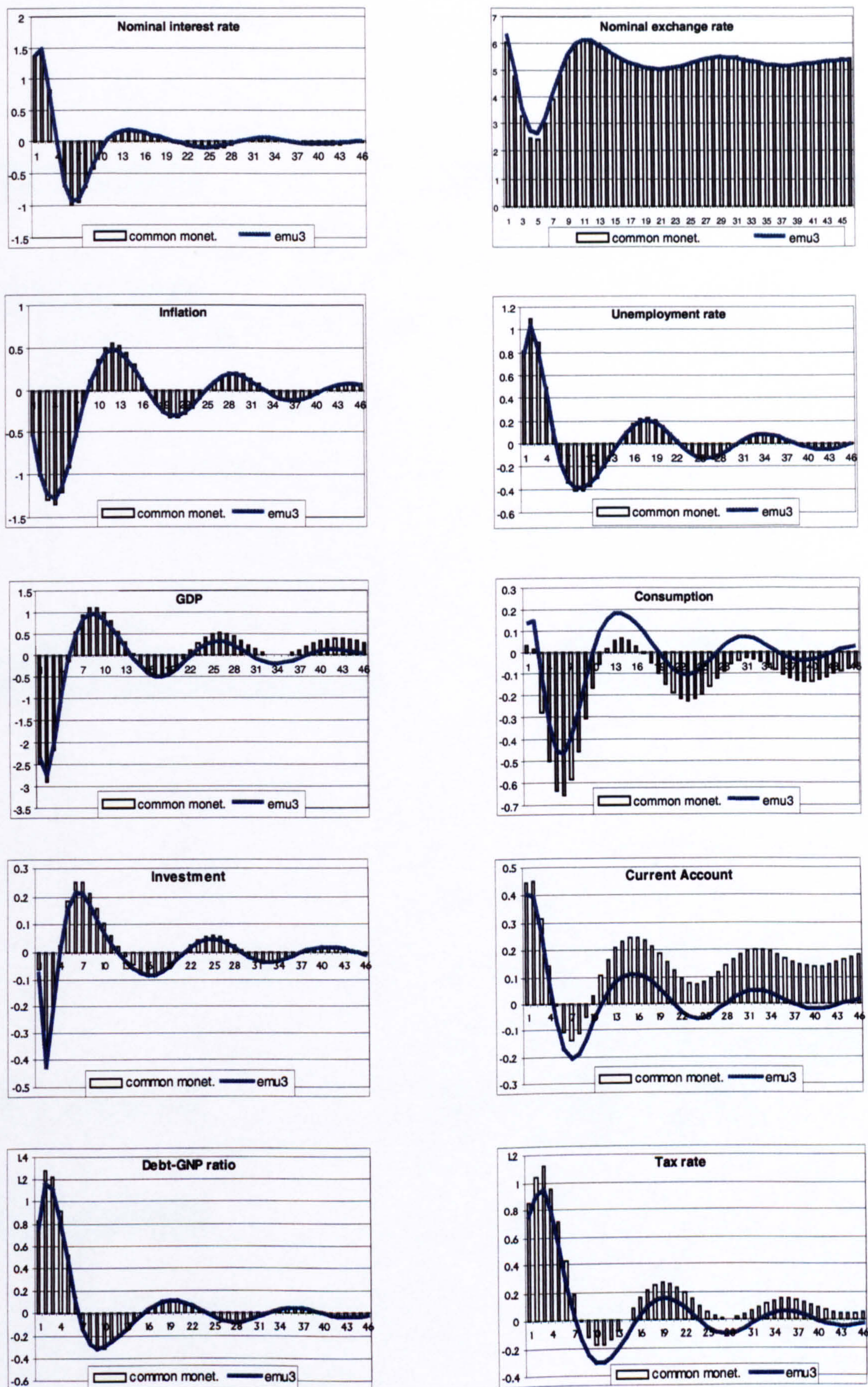
$$\left(\frac{B}{PY} + \frac{M^{EMU}}{\sum_j P_j Y_j} \right) \left[1 - \frac{1}{\bar{\pi} \bar{g}} \right] = \frac{B}{PY} \left[\frac{\bar{r}}{\bar{\pi} \bar{g}} \right] + \frac{(G - T)}{PY}. \quad (5.15)$$

In particular, given the kind of shock simulated in the experiment, the rate of money growth remains constant at 4.96 percent in the new equilibrium. However, steady-state money bases vary as a simple consequence of aggregating across national money stocks. It follows that the more dissimilar expected national money ratios are, the more evident (long-run) asymmetries in the transmission of the monetary shock will be.

Under the current set-up, inherent mechanisms of transmission of *fiscal policy shocks* are at work alongside the above-mentioned short-run interest rate adjustments. In this respect, steady-state implications of permanent shocks to budget deficit are mainly driven by the degree of “non-Ricardianess” embodied in the model. This strictly depends on the degree to which consumers are assumed to count government bonds as net wealth. In MM3, as we have noticed before, households adjust their savings by only part of the higher future tax burden associated with permanently higher government debt. Actually, agents treat a portion of government bonds as net wealth because they excessively discount the future higher tax liabilities necessary to meet the intertemporal budget constraint. Both disconnectness of today’s generations from future ones and life-cycle considerations imply that permanently higher level of primary deficits will be associated with a tendency to overconsume current resources. This will induce higher real interest rates and, eventually, lower capital stock and lower sustainable levels of real income. The reverse is true in case of permanent reductions in primary deficits.

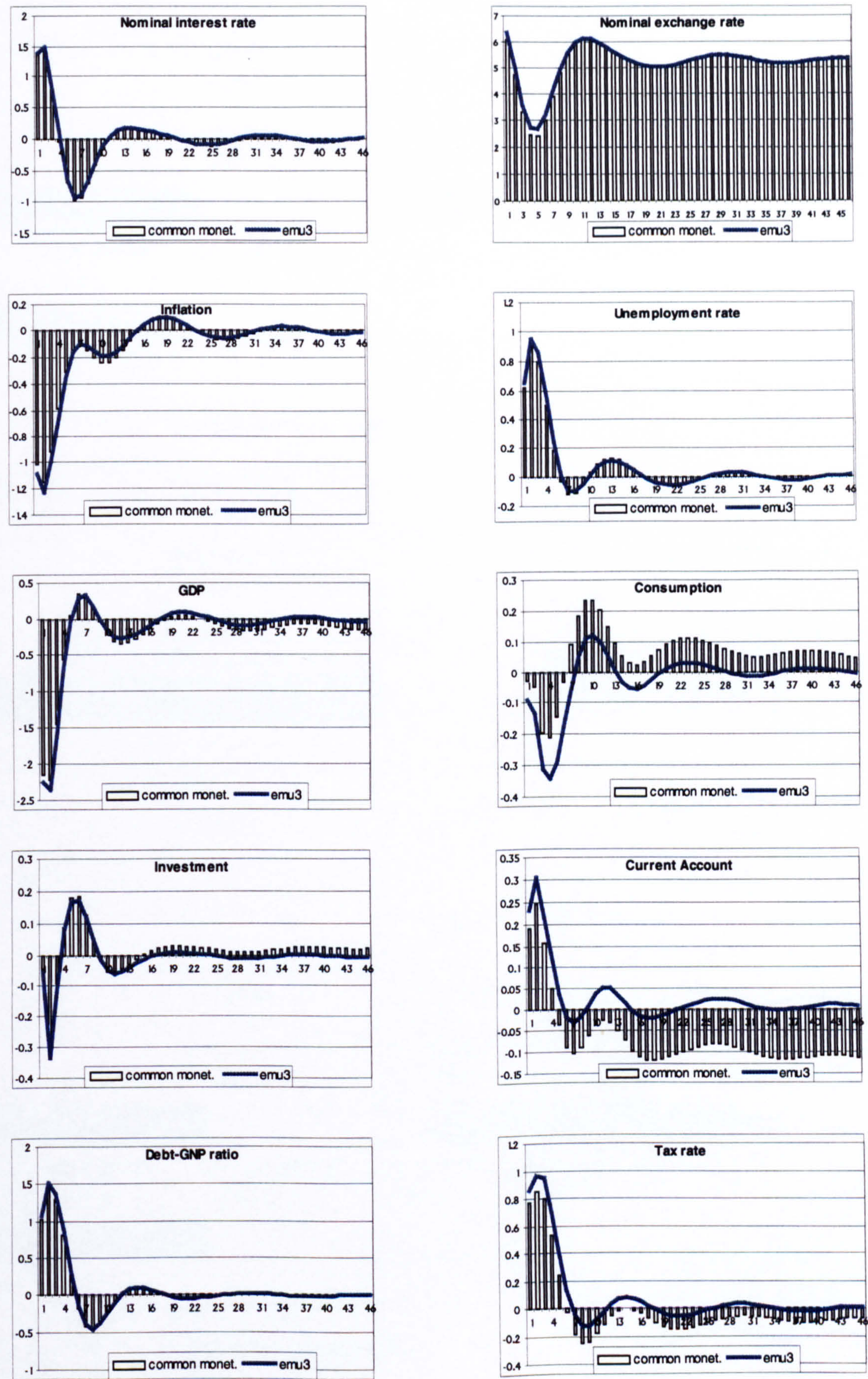
Results for this experiment are illustrated in Figures 5.2 to 5.4, for Germany, France and Italy, respectively. Their post-shock equilibria for money ratios are reported in table 5.3. The corresponding *common* post-shock steady-state value is, instead, 7.78 per cent. This implies that whereas a country like Germany will face a permanent *reduction* in money financing, a country like France will enjoy an increase in seigniorage revenues. The comparison between the cases of Germany and France is striking. Though their responses keep being similar in the order of magnitude, their adjustment paths and steady-state values with respect to consumers' expenditure differ here substantially. As Germany is in deed experiencing a permanent *reduction* in money financing with unchanged debt and spending ratios in the face of the common monetary shock, a consistently *higher primary surplus* is expected to characterise its new equilibrium². Long-run responses for Italy are similar to those for Germany as their initial money ratios do not differ significantly. The cases of Germany and Italy mimic, indeed, permanent fiscal contraction (on this point see also the appendix). As such, for these two countries, having a common money supply is likely to bring about a lower equilibrium level of consumption (approximately 0.1 percent) and higher new steady-state values for current account balance and real GNP (on the order of 0.2 and 0.3 percent, respectively), as plotted in Figures 5.2 and 5.4.

Figure 5.2: GERMANY - Deflation experiment within EMU-3 under common seigniorage revenues



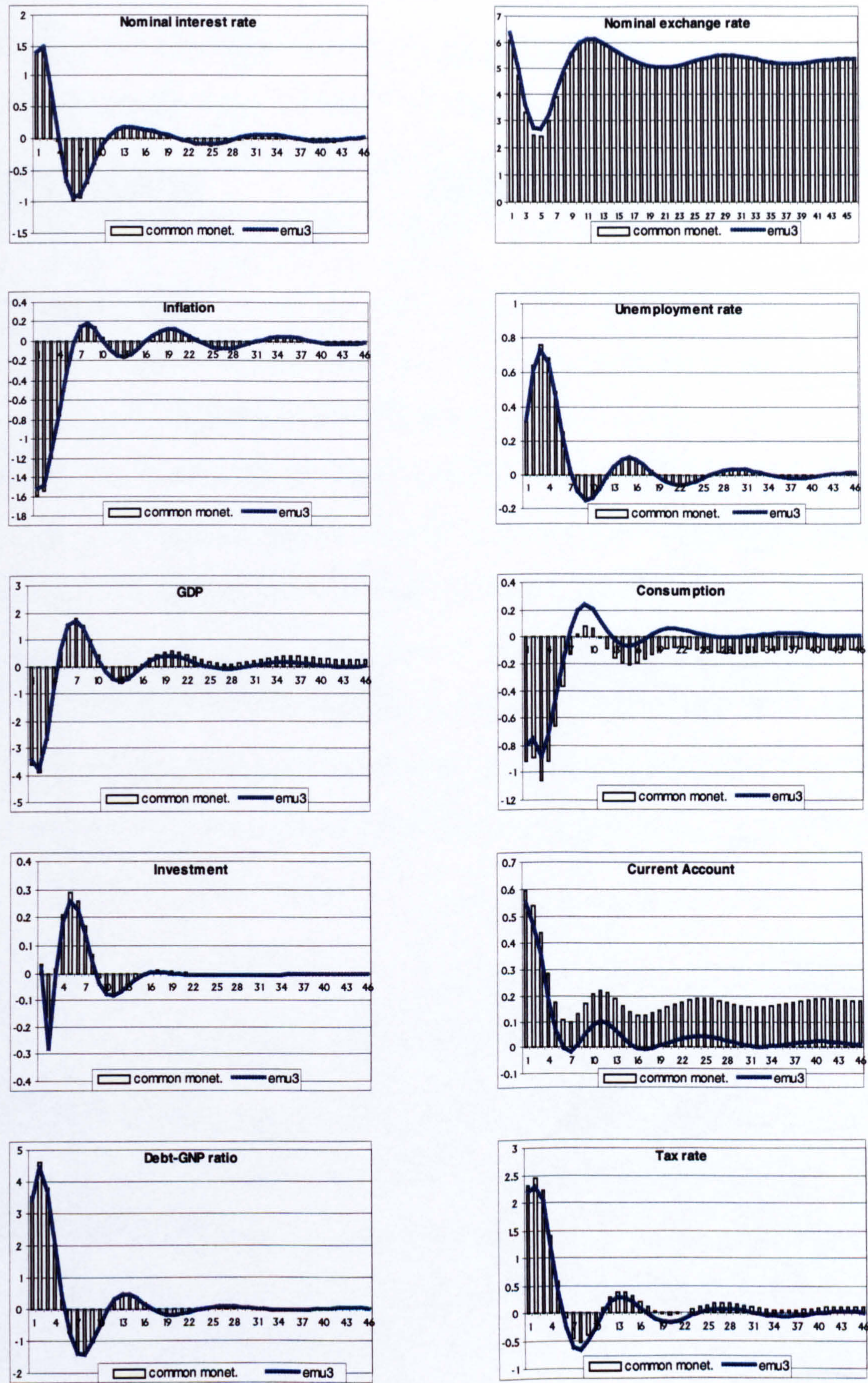
See note Figure 5.1

Figure 5.3: FRANCE - Deflation experiment within EMU-3 under common seigniorage revenues



See note Figure 5.1

Figure 5.4: ITALY - Deflation experiment within EMU-3 under common seigniorage revenues



See note Figure 5.1

As it is evident from the consumption plot in Figure 5.3, conclusions are diametrically opposite in the case of France, where a deflationary shock combines its effects with those of an implicit *permanent* fiscal expansion. The case of France reflects, therefore, all the long-lasting distortionary effects explained above. Namely, consumption rises in equilibrium by some 0.05 percent, current account balance shrinks by approximately 0.1 percent, with a fall in steady-state GNP on the order of 0.15 percent.

To check that such long-run real effects emerge as a mere consequence of wealth redistribution and *not* because of money non-neutralities, one should notice that, at aggregate European level, nominal interest rate eventually comes back to base and so does real exchange rate. It should be clear therefore that, in a model in which bonds and money are counted as net wealth, the primary source of cross-country heterogeneity in response to a common monetary shock is the differences in national economies' budgetary positions. Centralising money supply seems then to induce long-term cross-border wealth redistribution in response to a common monetary shock, unless accompanied by offsetting country-specific corrections in their debt stocks. This is however very unlikely to happen in practice, as both the degree of international policy coordination and the cost of information involved would be ridiculously high.

5.4.3. *Strict enforcement of the Stability and Growth Pact*

What if the World Economic Outlook baseline forecasts embodied the assumption of a strict enforcement of the SGP on the part of Italy? As already shown by Winckler *et al.* (1998), Maastricht criteria are unlikely to constitute either a necessary or a sufficient condition for the sustainability of a deficit-debt pair. The implicit assumption embodied in MM3 baseline forecasts – i.e. Italy will be running a *permanent* deficit of 4.7 percent of GNP while maintaining a debt-to-GNP ratio above 89 percent – is, as a fact, pointing to the same conclusion. In spite of these considerations, in the current simulation experiment we assume

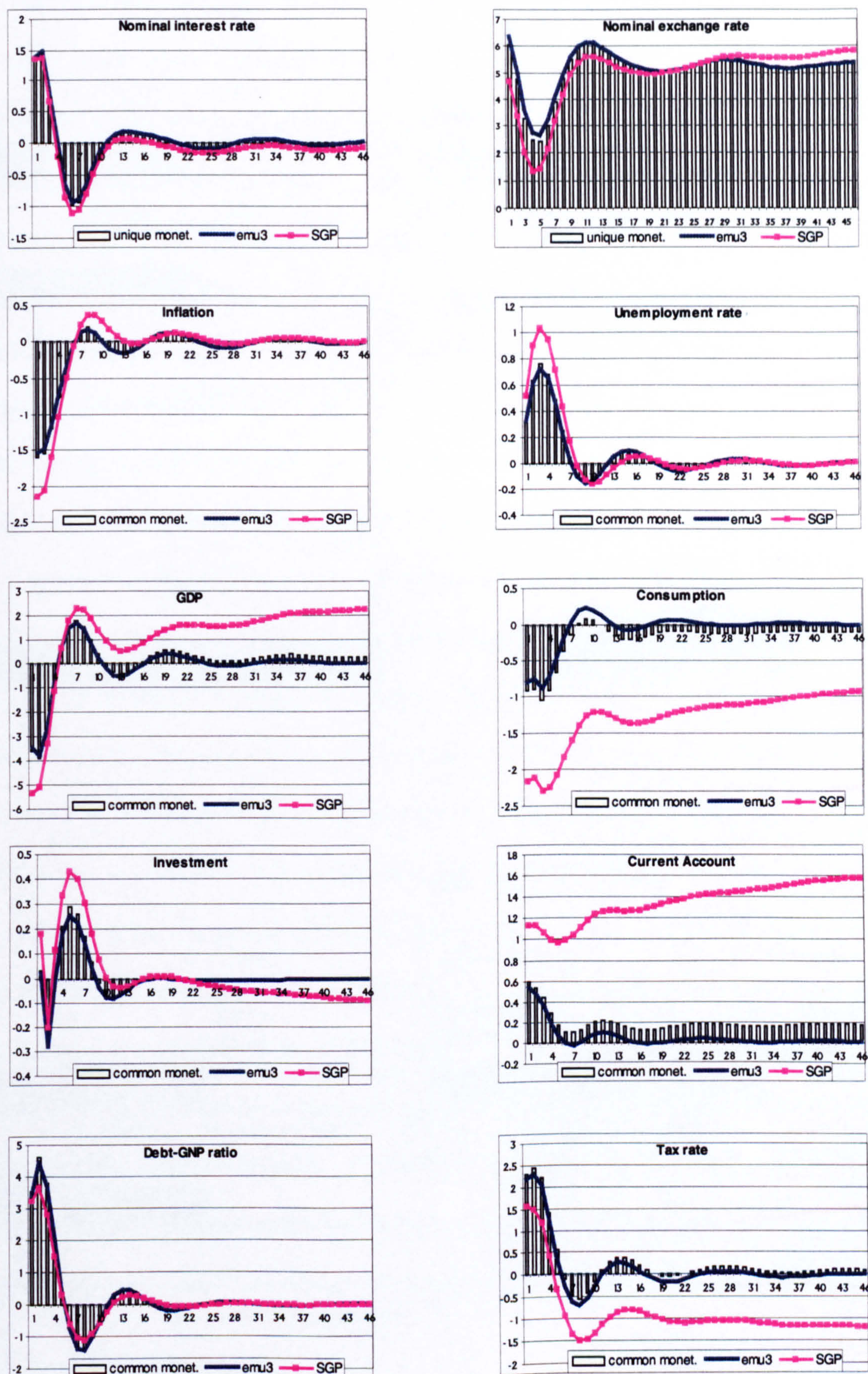
that Italy will be forced, somehow, to maintain its permanent deficit ratio at 3 percent. This is done by reconstructing the baseline in a consistent manner. The new steady-state deficit ratio can be sustained at constant money and spending ratios, if the debt ratio is assumed to converge to 53.87 percent. As we limit ourselves to re-calculate the residuals of fiscal reaction functions, the long-run Italian response in tax rate denotes the reduction in the primary surplus that Italy can enjoy in the new steady state (see appendix). In line with the previous scenario, we keep assuming that money financing is centralised in the hands of the ECB.

In Figure 5.5 the responses to the deflationary shock triggered by the ECB, under the implicit assumptions that Italian debt-GNP ratio is reduced in steady state by more than 30 percent, are denoted with “SGP” (in other words, while the baseline value for the debt ratio response is 89.3 under the ‘emu3’ and the ‘common monetisation’ scenario, it is in fact reduced to 53.9 under ‘SGP’). The model specification is the same as in the ‘common monetisation’ experiment.

Given the relevance of the shock and the degree of Ricardian non-neutralities in MM3, it is not surprising that the new steady state for consumption is lower than the initial equilibrium value by 1 percent of baseline GNP. As a result of the reduction in government bonds, the current account surplus in the new equilibrium is higher by 1.5 percent of baseline GNP, with real output rising in equilibrium by more than 2 percent. Contrary to the entire set of results obtained so far, under this scenario the new equilibrium features a slight appreciation of the Euro in real terms and a drop in Euro-wide real interest rates. This is because we are simulating here a common monetary shock coupled with an asymmetric permanent reduction in the Italian government debt. Steady-state nominal interest rate is hence endogenously reduced to re-equilibrate international saving and investment, whilst inflation remains neutral.

Simulation confirms, therefore, that there exist ever-lasting benefits from strict enforcement of the SGP, with cross-border positive spillovers. However, short-run adjustment to the new steady state appears to be remarkably costly for a country like Italy. This is due to the fact that any effect of sizeable fiscal consolidation must be regarded as additional to the tightening in monetary conditions following the ECB deflationary shock. Under this scenario inflation falls in the first year by more than 2 percent with a dramatic recession in output on the order of over 5 percent and a rise in unemployment of over one percentage point.

Figure 5.5: ITALY - Deflation experiment within EMU-3 under common seigniorage revenues and strict enforcement of the SGP

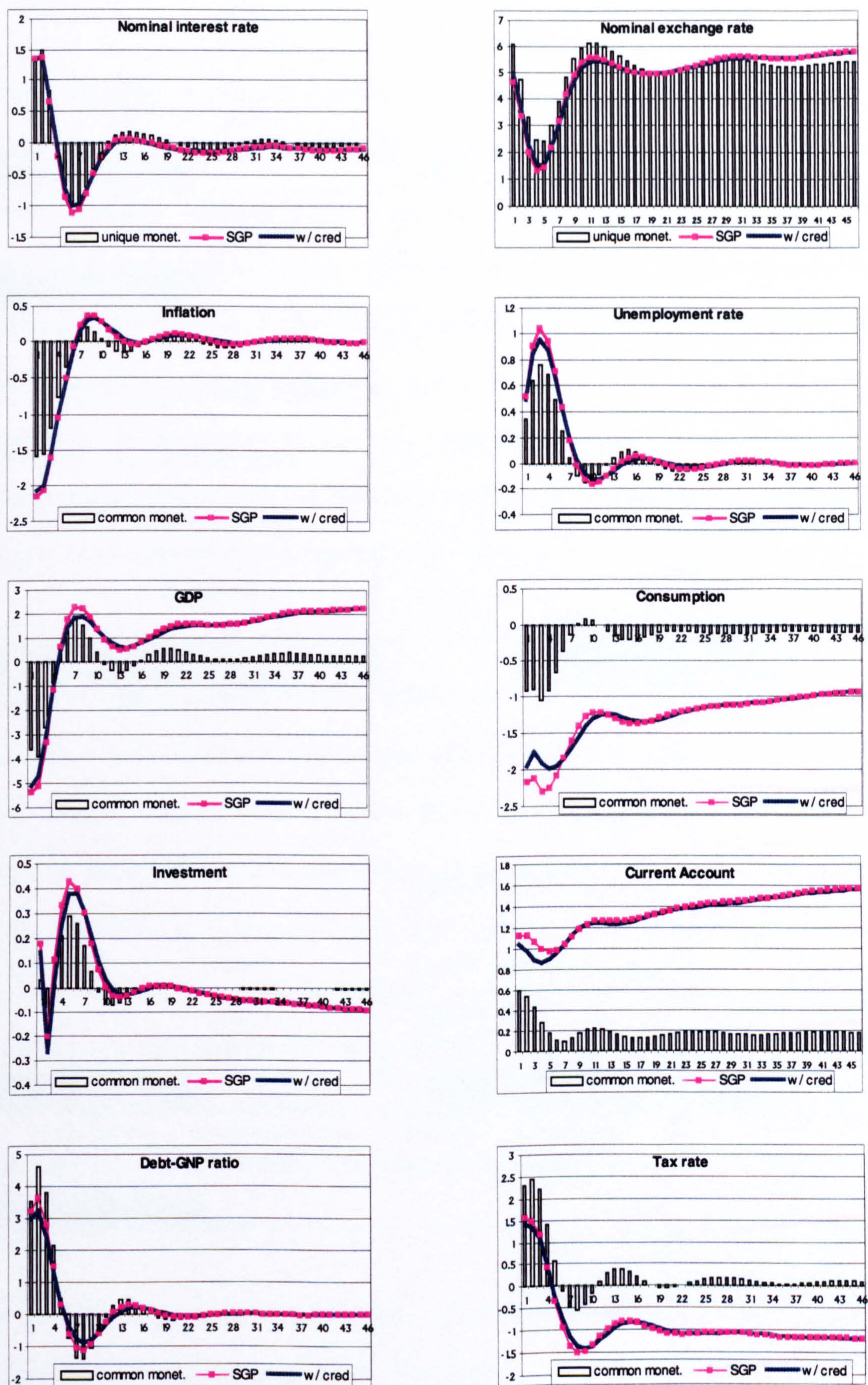


See note Figure 5.1

5.4.4. *Increasing efficiency in credit market*

In this final experiment, we remove the assumption that the degree of efficiency in credit markets differs across European economies. Namely, we exogenously reduce the share of credit constrained consumers at any life stage to 60 percent, all over Europe. This is intended to reduce both 'excess sensitivity' of consumption to income, thereby eliminating a potential source of Ricardian non-neutrality, and the degree of asymmetry in the structures of the European economies. The same deflationary shock to the EMU-3 monetary aggregate is then simulated under the joint assumption of common seigniorage revenues and strict enforcement of the SGP on the part of Italy. Results (reported in Figure 5.6 for Italy only) are thereby directly comparable with those from the 'SGP' experiment. Even limiting our attention to the Italian credit market, which was originally characterised by the highest share of liquidity-constrained consumers, responses look essentially unchanged. This can be explained by the fact that cross-country asymmetries in monetary transmission are found to be mainly driven by long-run (financial) wealth effects. Financial wealth is relevant for unconstrained permanent-income households, whose intertemporal consumption-saving choices are forward-looking and independent of changes in current disposable income. In this respect, it is the rate of time preference, that is the wedge between private and market discount rate, that matters. Reducing excess sensitivity of consumption seems to produce (if any) only short-term effects on consumption. We conclude that increasing efficiency in credit market is unlikely to be very effective in reducing adverse policy non-neutralities induced by the shrinkage in deficit financing associated with both common degree of money financing and strict enforcement of the SGP. Besides, different degrees of efficiency characterising European credit markets *per se* do not appear to play a major role in explaining cross-country heterogeneity in monetary transmission.

Figure 5.6: ITALY - Deflation experiment within EMU-3 under common seigniorage revenues, strict enforcement of the SGP and increased efficiency in credit market



See note Figure 5.1

5.5. CONCLUDING REMARKS

Despite convergence pressures, significant differences in structures and responsiveness to policy changes are still acknowledged across EMU member states. This chapter provides a model-based quantitative exploration of the effects of a common monetary stance when neither the degree of labour markets' rigidity nor the level of public debt ratios is expected to converge across countries. It shows that, under these circumstances, country-specific short-run adjustments to changes in European monetary aggregates will differ in both size and persistence. If the medium-to-long term money/debt composition of national deficits financing is anticipated to remain different across EMU economies, then ever-lasting effects from cross-border wealth redistribution are also likely to arise.

It is certainly possible to argue that, given the presence of short-run constraints, different degrees of rigidity in country-specific inflation-output relationships are alone *sufficient* to undermine synchronisation in their business cycle in the face of a common monetary shock. This certainly raises the question whether this is also a *necessary* condition for symmetric monetary responses, that is whether labour market discipline is able to ensure convergence on its own. However, as responsiveness to monetary changes is found to be greater - *ceteris paribus* - in high-debt countries, increased nominal and real flexibility in their labour markets might well trigger further booms and busts in the face monetary shocks, rather than favour macroeconomic stabilisation. As the matter carries important implications for the order in which structural reforms in these countries need to be undertaken, it certainly calls for further investigation.

Nonetheless, the analysis of the differences in the structure of European economies does not end with labour market considerations. MacLennan *et al.* (1998), for instance, stress how institutional differences in financial and housing markets across EMU countries may indeed constitute barriers to convergence and increase the potential for financial instability within

the Union. Sensitivity analysis to alternative calibrations of the model and related changes in model specification would then also be of interest for further research on the issue. In fact, though in MM3 cross-country differences in the behaviour of agents are generally reflected in country-specific parameter calibration, this is not always the case. For example, in the consumption function MM3 employs *pooled* estimates of the intertemporal elasticity of substitution, which is hence constrained to be the same across G-7 countries. It is unanimously recognised how critical such a parameter is in affecting the degree of debt non-neutralities, since it determines the sensitivity of consumption to changes in the monetary policy instrument. As it is allowed to vary across economies, further asymmetries in monetary transmission are also likely to arise. Analogous considerations apply with respect to the concave earnings profiles, which are believed to portray life-cycle consumers' labour income. The related coefficients are estimated using data on labour income and employment by age only for the United States and are then imposed to be invariant across all the other countries. Jappelli and Pagano (1989), however, do not find any support for cross-country homogeneity in this regard. Once again, country-specific effects of debt stabilisation on consumption-saving behaviour should then be re-assessed on the basis of sounder parameter estimates of the model.

APPENDIX

A simple version of MM3's fiscal submodel (5.10)-(5.11)-(5.12) is used in this appendix to illustrate analytically the theoretical underpinnings of the simulation results discussed in sections 5.4.2 and 5.4.3. While the intertemporal budget constraint (5.11)-(5.12) is unchanged, the fiscal reaction function in (5.10) is here simplified to a tax difference rule responding to current deviations of the debt ratio from target.

$$\Delta B_t + \Delta M_t = r_t B_{t-1} + (G_t - T_t) \quad (\text{A.1})$$

$$\Delta t_t = \tau (b_t - \bar{b}) \quad (\text{A.2})$$

In (A.2) t_t denotes the average tax rate, b_t the debt ratio and \bar{b} the corresponding target value.

Recalling from Section 5.2 that all the variables in (A.1) are expressed in nominal terms, we can re-define nominal total taxes, nominal public debt and high-powered money as ratio to nominal GDP, so that:

$$t_t \equiv \left(\frac{T}{PY} \right)_t; b_t \equiv \left(\frac{B}{PY} \right)_t; m_t \equiv \left(\frac{M}{PY} \right)_t.$$

Moreover, growth rates are denoted as follows:

$$\pi \equiv \frac{P_t}{P_{t-1}}; g \equiv \frac{Y_t}{Y_{t-1}}; \sigma \equiv \frac{M_t}{M_{t-1}},$$

with $\sigma = \pi g$ at any time, and kept constant throughout³. Under the innocuous assumption of constancy of government spending, further normalised to zero, $(G/PY)_t = k = 0$, t_t also indicates the primary surplus and (A.2) its corresponding motion law. Thus, dividing (A.1) by $P_t Y_t$ and re-arranging, we obtain the following system of difference equations:

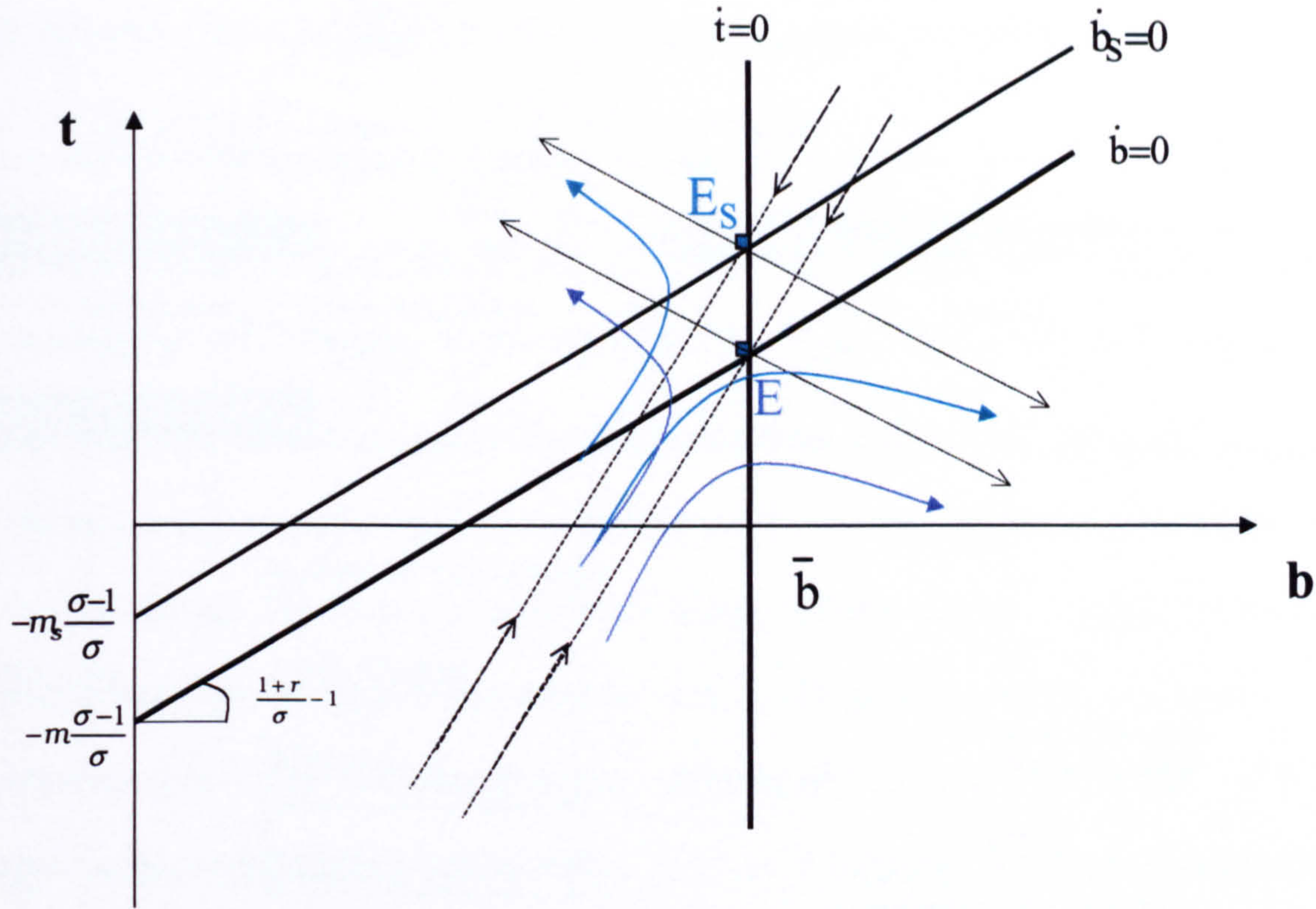
$$\Delta b_t = \left[1 - \frac{\sigma}{(1+r)} \right] b_t - \frac{\sigma}{(1+r)} t_t - \frac{(\sigma-1)}{(1+r)} m_t \quad (\text{A.3})$$

$$\Delta t_t = \tau (b_t - \bar{b}) \quad (\text{A.4})$$

By limiting our attention to the dynamics of (b_t, t_t) pairs, while assuming any other macroeconomic variable as given, we rule out by construction Sargent and Wallace's (1981) Unpleasant Monetarist Arithmetic. The monetary authority enjoys here the first mover advantage (the so called role of Stackelberg leader), knowing that the fiscal authority will react by adequately adjusting its policy. This framework is quite plausible for EMU countries as the European Central Bank is independent and cares about price stability (thereby targeting π or σ), while Maastricht criteria should prevent fiscal agencies to run excessive deficits. However, it can be shown that, even under these circumstances, monetary policy may be required to step in and a monetary policy switch to inflationary policy may be needed to ensure debt stabilisation.

Let us consider the two scenarios we referred to in section 5.4.2 and 5.4.3. Under the first scenario, m_t is meant to fall exogenously to a lower level; under the second scenario, an institutional arrangement such as the SGP is somehow enforced and \bar{b} is, thereby, correspondingly reduced. We can show that, in both cases, the likelihood of unsustainable fiscal pairs increases. The phase diagram of equations (A.3)-(A.4) under the first scenario is drawn in Figure 5.7, whereas the second scenario is depicted in Figure 5.8.

Figure 5.7: Implications of common seigniorage revenues for Germany and Italy: phase diagram



Point E is the steady state. In this position, debt is at its target level \bar{b} , so that there is no tendency for taxes to move, while the primary surplus necessary to stabilise b without creating extra inflation, given an interest rate r and a growth rate g , is determined by:

$$\bar{t} = \left(\frac{1+r}{\sigma} - 1 \right) \bar{b} - \left(\frac{\sigma-1}{\sigma} \right) m_t \quad (\text{A.5})$$

The equilibrium is a saddle point with an upward sloped stable manifold identified by the following eigenvector:

$$\left[-\frac{-1+\sigma-r+\sqrt{(-1+\sigma-r)^2-4\sigma(1+r)\tau}}{2(1+r)\tau}, 1 \right] \quad (\text{A.6})$$

Any pair (b_0, t_0) below it represents an unsustainable fiscal stance: in these initial position the speed of fiscal adjustment τ is too low so that \bar{b} is reached before the primary surplus has been sufficiently increased. An inflation target π (or, equally, a target for the debt ratio \bar{b}) is

likely to be eventually abandoned. The slope of the stable arm determines, therefore, the sustainability condition of national fiscal stances. The higher the speed of fiscal adjustment, τ , the steeper is the saddlepath and the more pairs (b_0, t_0) are sustainable.

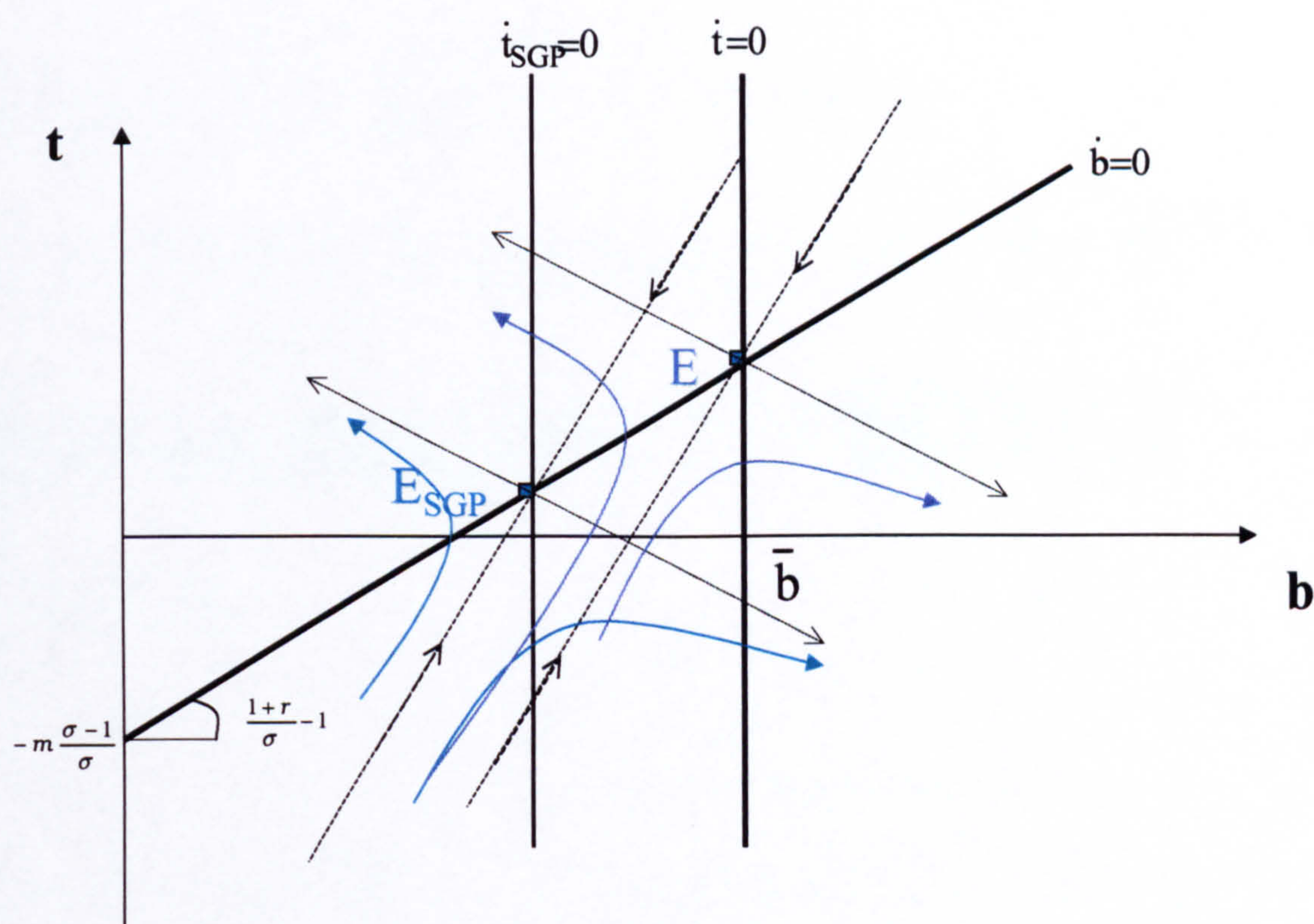
Let assume a permanent fall in money balances as percentage of GDP, due either to an exogenous increase in money velocity or to cross-border wealth redistribution following centralisation of European seigniorage revenues. Such a shock will shift upwards the intercept of the locus $\dot{b} = 0$ by $(\sigma-1)/\sigma$ times the change in money balances (see Figure 5.7). The new steady state (E_s) will thus be characterised by the same target for debt-to-GDP ratio as in E , though featuring a proportionally higher primary surplus. Moving upwards the equilibrium position brings about a similar shift of the stable manifold. As a result of the reduction in m_t , every debt-primary surplus pair lying above the old stable arm but below the new one becomes suddenly unsustainable. To rule out the possibility of an accommodating monetary policy we need to assume that the new fiscal target (i.e. the higher equilibrium level of taxation) is fully credible, so that the economy will immediately jump onto the new stable path as the policy change is announced. This is basically the assumption implicit in the simulation results presented in section 5.4.

Consider now the case of an exogenous reduction in the debt-to-GDP target (\bar{b}), as visualised in Figure 5.8. According to (A.5), under the new steady-state E_{SGP} , the primary surplus necessary to stabilise b without creating extra inflation will also be lower than under the initial equilibrium position E . Nonetheless, as the slope of the saddlepath is greater than that of the locus $\dot{b} = 0$ (compare A.5 with A.6), a movement of the steady state from E to E_{SGP} will also shift the stable manifold upwards. Hence, as it was the case under the previous scenario, strict enforcement of the SGP criteria increases the likelihood of unsustainable fiscal pairs. Conclusions are, thus, analogous.

Finally, it is interesting to notice that exogenous shocks to money base and debt target may have offsetting effects on steady-state fiscal positions. Namely, given the reduction in money

base under the first scenario, it seems feasible (at least in theory) to counteract this shock through an increase in the objective of the fiscal authority, such as to bring the economy back on the old stable arm (although not towards the old equilibrium position itself). Similarly, under the second scenario, given an exogenous reduction in the debt target, the economy could move back on the old stable manifold had the money base increased appropriately.

Figure 5.8: Implications of enforcing SGP criteria for Italy: phase diagram



Chapter Six

When is Labour Market Flexibility Welcome? More on Asymmetric Policy Impacts in Europe

6.1 INTRODUCTION

Since the Delors Report was published in April 1989, a lively debate has ensued among macromodelling groups about the costs and benefits of Economic and Monetary Union (EMU) in Europe.

The first notable attempt to use empirically-based macromodels to evaluate the economic performance of EMU relative to an Exchange Rate Mechanism (ERM) with occasional realignments was made by the EC Commission's study 'One market, one money', (1990). It used stochastic simulation of the IMF's MULTIMOD model to compare variability of output

and inflation under alternative exchange rate arrangements and concluded that EMU reduces average inflation variability (but at the cost of increased average output variability). Masson and Symansky (1992), using the same approach and model, do not find any strong evidence in favour of EMU over the alternative regime; on the other hand, they conclude that ERM is much less of a potential source of instability than implied by Minford and Rastogi (1990). Minford and Rastogi, also in a revised version with Hughes-Hallett (1993), using the Liverpool annual global model, argue that the best regime for EC countries would be floating with monetary policies co-ordinated either world-wide or within EC-coalition; the European Monetary System (EMS), instead, as it allows for realignments, would produce instability.

Such initial debate mainly concentrated on two issues: (i) the gains from the elimination of transaction costs and exchange rate uncertainty, which turn out to depend crucially on the method of estimation of risk premia and the modelling of exchange-rate realignments under EMS; (ii) the costs of losing or pooling sovereignty, which are uniquely determined by the nominal and real rigidities present in the underlying model.

More recently, the context of the analysis has changed dramatically. The debate among both economists and policy-makers has moved on, to how to make EMU work as a new macroeconomic structure. EMU institutional design was defined well before its official starting date, on 1st January 1999. The statute of the European System of Central Banks singled out price stability as the primary goal of policy and made the ECB responsible for the stability of the payments and financial system. The Pact for Stability and Growth, agreed at the Amsterdam summit in the summer 1997, left fiscal decisions in the hands of eleven independent national authorities while endorsing continuing fiscal virtue. Nonetheless, a large degree of uncertainty still remains over what the macroeconomic structure of the new Europe should look like. The reaction function of the ECB is unknown and its target is unlikely to be published. The way in which the ECB board is likely to vote is also uncertain, thereby raising the concern that national interests might actually overcome a genuinely European perspective. Country-specific fiscal reaction functions are equally unknown, with

the further crucial question about whether fiscal policies should be co-ordinated, not only among themselves but also with the actions of the monetary authority.

The related macroeconomic literature is vast, but fails to reach agreement even on *whether* policy co-ordination is *per se* desirable. On theoretical grounds, harmonisation of monetary and national fiscal policies is generally welcomed, to prevent a sub-optimal mix of loose fiscal and tight monetary policies from leading to hard landings with seriously rising unemployment/welfare costs (Begg *et al.*, 1998; Allsopp and Vines, 1998; Demertzis *et al.*, 1999). Empirical studies, however, seem to suggest that the benefits from policy co-ordination are almost negligible (Oudiz and Sachs, 1984; Masson and Taylor, 1993).

The picture remains blurred even if empirical scepticism is set aside. The yet-to-be-resolved issue then turns into *how* monetary, fiscal and supply-side policies should be co-ordinated across Euroland in order to favour achievement of Euro-wide policy stabilisation goals. On one side are those who argue that a European country which ties its monetary hand behind its back should retain fiscal flexibility as an instrument of adjustment. Eichengreen and Wyplosz (1998), for instance, suggest that there is a danger that the Excessive Deficit Procedure and SGP will limit counter-cyclical fiscal action, thereby threatening EU growth. On the other side are those who insist that lax enforcement of such institutional agreements is likely to bring greater pressure to bear on the European Central Bank. Under these circumstances, the credibility of the latter's commitment to price stability would be greatly lessened (Alesina and Grilli, 1992; Bolt, 1999). Another rationale for fiscal restraints is to internalise cross-border interest-rate spillovers. Within a monetary union, excessive debt financing in one country will raise the level of interest rate Europe-wide, unless international fiscal responsibility is enforced (Beetsma and Uhlig, 1999).

Moreover, the objective of macroeconomic policy co-ordination in EMU is complicated by the evidence that EU member states show significant differences in structures and responsiveness to policy changes. MacLennan *et al.* (1998) stress how institutional

differences across EU member states - which are at the origin of such different responses to common policy changes - may constitute barriers to convergence and increase the potential for financial instability within EMU, unless corrected. Using simulation of MULTIMOD Mark III, we have shown in the previous chapter that possible asymmetries in monetary transmission may convert a common monetary policy into different national outcomes; in particular, national budgetary positions are likely to be a primary source of long-lasting divergences. Hughes Hallett *et al.* (1998), via deterministic simulations of the Fair multicountry econometric model, point out that a common monetary policy can generate large country-specific effects. Dornbush *et al.* (1998) use vector autoregression analysis to compute national responses to common and simultaneous changes in interest rates (for a similar approach see also Gerlach and Smets, 1995, and De Bondt, 2000). Although asymmetries are smaller than reported in the abovementioned studies, they do not seem to vanish in the long run.

Clearly, the diverse response across countries is a serious problem on its own right but no one can deny that rather little is known about how the system as a whole is expected to react to common interest-rate changes. Not only the behaviour of monetary aggregates is likely to be subject to structural breaks. The degree of wage and price flexibility, the characteristics of the wage bargaining and price-formation processes, not to mention the mechanism of expectation formation, are also unlikely to remain unchanged. In this respect the Lucas critique bites quite hard. As the option of exchange-rate changes to facilitate adjustments is no longer available in a monetary union, and fiscal policy is also constrained by the 3% ceiling to the deficit ratio imposed by the SGP, both workers and policymakers will recognise the need to substitute greater labour-market flexibility. This can materialise in the form of both wage adjustments and worker mobility. In other words, giving up monetary and fiscal freedom will increase efforts at labour-market reforms simply because there is no other choice. Nonetheless, the thesis that the existence of a Monetary Union would favour the

emergence of (national) wage adjustment mechanisms has been challenged by the literature in many respects.

First, there are objections grounded on natural-rate considerations (Buiter, 1995): as money is neutral in the long run, monetary policy simply does not have the ability to influence long-term divergences in real economic structure, real wage rigidities or any other real development that matters. *A fortiori*, the choice of the monetary regime is irrelevant when nominal rigidities are at issue. As nominal rigidities are transient, changes in policy/institutional arrangements that would compensate for the loss of national monetary sovereignty need only to have temporary effects. However, hysteresis provides an argument against such a position. Empirical estimates on European data show that structural unemployment follows actual unemployment developments closely, thereby making the natural rate model inadequate for the European context (Blanchard and Katz, 1997). Real business cycle studies also confirm that strong persistence effects may arise when nominal and real wage rigidities co-exist, irrespective of the natural rate assumption (Jeanne, 1998). Furthermore, as we illustrate below, even though the Phillips curve is vertical in steady state, monetary policy can still affect long-run real outcomes if, for instance, non-linearities feature in the short-run inflation-output trade-off.

Second, it has been noticed that policy co-ordination might suffice to compensate for the lack of adjustment mechanisms. If Euroland shock absorbers are rigid and a likely source of hysteresis, then the ECB has simply to be relatively more prudent when tightening monetary policy in order to avoid hard landings with seriously rising unemployment (Begg *et al.*, 1998). Otherwise, as no adjustment mechanism is likely to shelter European countries from asymmetric shocks, a system of interregional fiscal transfers could compensate for such a lack. Obstfeld and Peri (1998) point out, however, that the existence of generous fiscal transfers could prevent the emergence of an effective market-based adjustment mechanism in Euroland, as it would provide a lasting disincentive against labour mobility.

Thirdly, and more strikingly, it has been argued that it is the shift to a monetary union itself that hampers labour market reform. Calmfors (1998), for instance, shows that the likelihood of labour market reforms is actually reduced by becoming a member of EMU. This is because labour market reforms are much easier to introduce if monetary policy is accommodating and supporting demand while labour flexibility is introduced. Hence, reforms are more likely to take place outside EMU, where supply-side and monetary policy can be co-ordinated. Dornbusch et al. (1998) argue that replacement of the national monetary authorities with the ECB will lead to disruption of the direct link between wage hikes and unemployment exactly for the opposite reason: as Euro-wide inflation does not rise one-for-one with decentralised wage hikes, the need for disinflationary policy on the part of the ECB will be less. The implicit accommodating ECB response will then remove much of the discipline now in place, bringing about either a rise in local equilibrium unemployment or a EMU-wide inflationary shock. The point that the degree of centralisation of wage bargaining affects the outcome in terms of wage inflation and equilibrium (un)employment is also made in game theoretical models such as Calmfors and Driffill (1988), Soskice and Iversen (1998), Cuckierman and Lippi (1999, 2000). These models show that strategic interaction among an increased number of uncoordinated unions and a single central bank results in a worsening of the inflation-output short-run trade-off faced by the monetary authority. In particular, they suggest that a switch to a monetary union is likely to make labour unions more aggressive, thereby increasing unemployment, as it reduces each union's perception of how inflationary its individual actions are. In this perspective, centralisation of monetary policy seems to call for a single pan-European union setting wage patterns for the entire Eurozone.

Burda (1999), in turn, speculates that *nominal price rigidities will increase* within Euroland, mainly for two reasons. Firstly, as Europe will look more like a closed economy and inputs will become increasingly nontraded goods priced in Euros, cost pressures will be restricted to 'domestic' labour markets, marginalising the importance of exchange rate changes in price decisions. Because such an 'inwardisation' process increases exposure to the sheltered

domestic market, the greater will be the incentive to price to market and to set nominal prices in advance for longer periods. Factors like customer relationships and menu costs will then become relatively more important, thereby favouring nominal rigidities. Secondly, as monetary policy credibility is enhanced, agents will expect lower inflation and be willing to fix nominal contracts for longer periods. At the same time, however, the author argues that *real wage rigidities* are likely to be *reduced*. This is due to a rise in product market competition, which translates into an increase in the elasticity of both product and labour demand. Moreover, the increasing importance of capital as a competing production factor as well as its growing transnationality is reckoned to attenuate the bargaining power of national unions. Given the incompatibility of current national structures with co-ordinated European bargaining, and given the limited EU budget to provide for accommodating social safety nets, local unions insisting on aggressive wage hikes are seen as simply facing higher local unemployment.

Who is right? Eichengreen (1998) tries to answer this question by surveying empirical evidence on the link between *nominal wage flexibility* and exchange rate regimes. He finds that studies looking across exchange-rate regimes (Alogoskoufis and Smith, 1991) or focusing on single-country cases (Gressani *et al.*, 1988; Kremers, 1990; Hochreiter and Winckler, 1995; Artus and Salomon, 1996) tend to confirm the existence of greater nominal wage flexibility when exchange rates are fixed. Cross-country econometric analyses, nonetheless, do not provide much evidence of an EMS-related structural break in the wage-determination process (Artis and Omerod, 1996).

Taking stock from such debate, this chapter provides a model-based quantitative exploration of the effects of a common monetary stance when monetary transmission mechanisms differ across countries. At the same time it tries to answer a number of relevant questions. Is the choice of institutional monetary arrangement neutral with respect to cross-country real divergences? Can labour market flexibility correct for asymmetric policy responses thereby

favouring convergence across European countries? Is labour market flexibility always good news? The answer is found to be negative in all cases.

We employ the IMF's multi-country model, MULTIMOD Mark III (MM3), which embeds a non-linear Phillips curve under the assumption of the existence of a natural rate of unemployment. In the presence of convexity of the inflation-output trade-off, it is possible to show that monetary policy choices have real effects in the long run. In particular, as discussed in section 6.2, a policy which is more effective in stabilising fluctuations in the business cycle is, under these circumstances, also able to lower the mean value of the unemployment rate.

Section 6.3 shows how different degrees of rigidity in country-specific inflation-output relationships are a sufficient but not necessary condition to undermine synchronisation in the business cycle in the face of a common monetary shock. The sensitivity of the asymmetries to alternative (uncoordinated vs. co-ordinated) monetary designs is assessed in section 6.3.1. In particular we note that, since a Monetary Union internalises cross-border exchange-rate fluctuations and enforces monetary co-operation, overall sensitivity to monetary policy is likely to be lessened. This would render the degree of cross-country heterogeneity less evident, at least with respect to the more rigid European economies, irrespective of any active labour market reform. Conversely, for countries characterised by higher (nominal and real) flexibility, EMU seems to induce policy overreaction compared with uncoordinated monetary stances. In this way, a Monetary Union could widen the gap between rigid and flexible European economies.

While these initial results are obtained under the assumption that all the economies are starting from conditions of full-employment equilibrium, such a pre-condition is removed in section 6.3.2. We can then show that different extant economic conditions represent weighty barriers to the process towards convergence.

Section 6.3.3 analyses the effects of increasing the degree of nominal and real flexibility in European labour markets. It is shown that for countries like Italy, characterised by a high level of initial debt, the output responsiveness to monetary shocks is greater than elsewhere, *ceteris paribus*. In these cases, allowing for greater nominal and real flexibility in the labour market may have undesirable consequences. Since a lower degree of rigidity implies a greater inflation responsiveness to output and unemployment conditions, we show that structural reforms of the labour market which are not preceded by fiscal consolidation may actually induce destabilising effects on the economy. We hence find support for Burda's (1999) conclusion that '[c]alls for additional flexibility may be the economic equivalent of whipping a dead horse, and could provoke counterproductive reactions'. Concluding remarks end the chapter.

6.2 THE TOOL OF ANALYSIS: MULTIMOD MARK III

To explore the implications of asymmetries in the transmission of monetary policy across European countries, we use the IMF's multi-country econometric model, MULTIMOD Mark III. In its basic version, it contains linked annual models for each of the G-7 economies plus three country blocks which aggregate the small industrial economies, the developing countries and the high-income oil-exporters, respectively. As a general equilibrium model, MM3 is well suited for policy analysis, since its explicit characterisation of technology, household and firm preferences allows for parameter calibration to replicate certain stylised facts. The model is however unsuitable for making unconditional forecasts. Rather, it takes the IMF's World Economic Outlook forecasts as the baseline for simulation scenarios. The structure and properties of MM3 are thoroughly described in Laxton *et al.* (1998), while its detailed documentation and codification can also be obtained at the IMF's external publication website (<http://www.imf.org>). Here we simply emphasise (i) the implications of employing a non-linear model of the inflation-output nexus; (ii) the modifications which are needed to simulate MM3 under alternative monetary regimes for Europe.

6.2.1 *A convex Phillips curve model*

Research in the inflation-output trade-off debate has traditionally relied on a linear analytical framework, assuming that the response of inflation to a positive gap between actual and potential output is equal and opposite to the response to a negative gap of the same size. Though analytically convenient, the linear model ignores the evidence that under conditions of full employment, inflation appears to respond strongly to demand conditions, whereas in deep recessions it is relatively insensitive to changes in activity. The case for asymmetry in the transmission mechanism between unemployment and inflation has been recently stressed by researchers at the IMF, with a growing literature on the topic (see, among others, Chadha,

Masson and Meredith, 1992; Laxton, Meredith and Rose, 1995; Debelle and Laxton, 1997; Clark and Laxton, 1997; Laxton, Rose and Tambakis, 1999).

In MM3 the entire system of wage and price determination is subsumed in a reduced-form expectation augmented Phillips curve. In the light of this research, it is not surprising that such a relationship is non-linear. The presence of a convex Phillips curve in MM3 reflects short-run capacity constraints in such a way that, whereas inflation responds strongly to demand pressures under conditions of full employment, it is relatively insensitive to changes in activity during recessions. The MM3 short-run inflation-output trade-off can be summarised by the pair of equations reported below, where (6.1) describes Okun's law, which translates output gaps $(y_t - \bar{y}_t)$ into unemployment gaps $(u_t - \bar{u}_t)$, and (6.2) specifies the short-run Phillips curve model. Corresponding country-specific parameter estimates are shown in table 6.1, limiting our attention to the four European economies that are separately modelled.

$$(u_t - \bar{u}_t) = 100 \cdot \rho_1 (y_t - \bar{y}_t) + \rho_2 (u_{t-1} - \bar{u}_{t-1}) \quad (6.1)$$

$$\pi_t = \lambda_1 [\delta_\pi \pi_{t+1}^e + (1 - \delta_\pi) \pi_{t-1}] + (1 - \lambda_1) \pi_{t-1} + \frac{\gamma}{100} \frac{(u_t^* - u_t)}{(u_t - \phi_t)} + \varepsilon_t \quad (6.2)$$

Table 6.1 Okun's Law and Phillips Curve parameter estimates

	Germany	France	Italy	UK
ρ_1	-0.33	-0.30	-0.09	-0.33
ρ_2	0.18	0.44	0.79	0.69
λ_1	0.744	0.753	0.912	1
δ_π	0.53	1	1	0.53
γ	0.819	1.137	2.305	2.364
ϕ	4.521	5.104	5.676	2.248
U^*	8.521	9.104	9.676	6.248

Equation (6.1) can be regarded as a demand function for labour, with output demand taken as given. Partial adjustment represented by ρ_2 implies that turnover is costly, so firms adjust employment slowly to changes in demand conditions. In line with the prevailing paradigm in macroeconomic modelling, the expectations augmented Phillips curve (6.2) retains inflation neutrality in the long run, while featuring some degree of inertia in the short-to-medium-term adjustment. Moreover, it distinguishes between intrinsic dynamics and expectation formation (the term in square brackets). Namely, the model embodies fixed weights on forward- and backward-looking components for inflation expectations (δ_π and $(1-\delta_\pi)$, respectively), which can however be modified to allow for alternative assumptions about expectation formation and policy credibility. Moreover, the model reflects an overlapping contracting framework, according to which a proportion λ_1 of workers negotiates nominal wage adjustments on the basis of expected future inflation, while remaining wage contracts are linked to lagged inflation. In this way, MM3 exhibits short-run Keynesian dynamics intended to capture inertial effects that are features of the inflation process. Finally, the non-linear term in unemployment can be derived from standard wage- and price-setting behaviour on the assumption that the degree of wage rigidity is a positive function of the actual level of unemployment, as is implicit in labour market theories such as the ‘efficiency wage’ model (see appendix for analytical derivation). As a consequence of such non-linearity, the higher the rate of unemployment, the greater the degree of real rigidity that characterises the labour market (embedded in the parameter γ). *Ceteris paribus*, this will make the curve flatter and real responses to aggregate demand shocks larger, as shown for instance in Debelle and Laxton (1997). In an EMU context, the assumption of a non-linear Phillips curve implies that country-specific adjustments to a common shock hitting aggregate demand depend crucially on the relative initial position of the economy, and not only on the parameter estimates of its short-run inflation-output trade-off (on this point, see section 6.3.3).

Another important implication of the convexity in the Phillips curve is the distinction between the NAIRU and the average rate of unemployment prevailing in the economy. This

distinction, which is not present in linear models of the Phillips curve, is illustrated in Clark and Laxton (1997) by considering the following expectations augmented model:

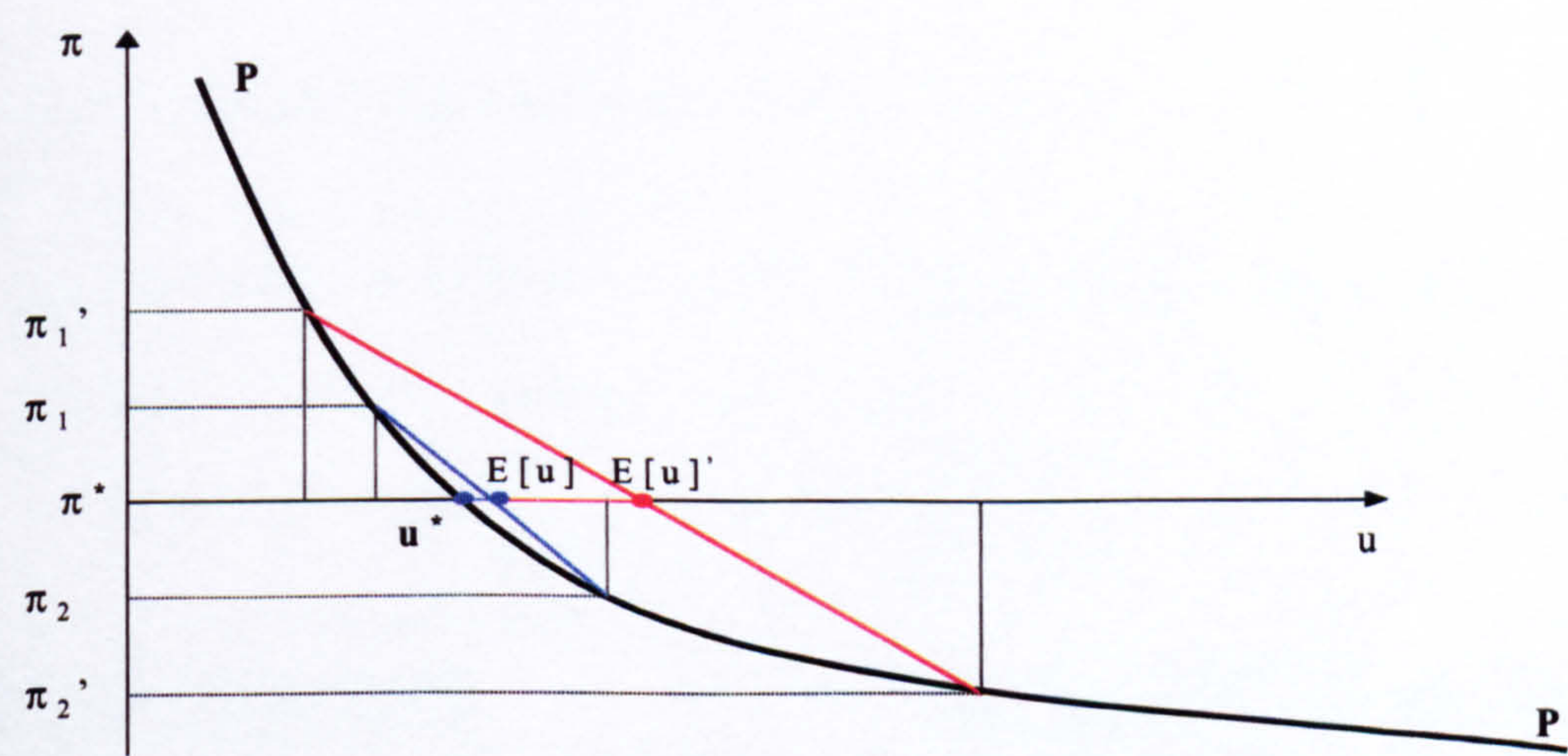
$$\pi_t = \pi_{t+1}^e + \Phi(\gamma(u^* - u_t)) + \varepsilon_t \quad (6.3)$$

where u^* indicates the NAIRU, i.e. the level of unemployment at which there is no tendency for inflation to depart from its steady-state value in the *absence of shocks* (say π^*), and $\Phi(\cdot)$ is some convex function that represents the effects of excess demand in the labour market on inflation, such that $\Phi(0)=0$, $\Phi'(\cdot)>0$ and $\Phi''(\cdot)>0$. Assuming that the error term ε_t is normally distributed with zero mean and that $\Phi(\cdot)$ is in fact a (symmetric) exponential function, then the *average rate* of unemployment in a stochastic steady state is given by $E[u_t] = u^* + \text{var}(u_t)/2$, which is greater than the NAIRU, u^* . The gap between the NAIRU and the *average* level of unemployment generated by an average set of shocks is, thus, a function of both the variance of the idiosyncratic shock and the way in which this translates into unemployment variability $\text{var}(u_t)$. This, in turn, depends on the specific non-linear function subsuming the model, i.e. $\Phi(\cdot)$, and its degree of curvature. The basic intuition behind is that, since the Phillips curve is convex at the origin, any excess demand in the labour market is more inflationary than excess supply is deflationary. Hence, the mean value of excess demand conditions $(u^* - E[u_t])$ must be negative for inflation to be stable. In these circumstances, any policy which is more effective in stabilising fluctuations in the business cycle is also able to lower the mean value of the unemployment rate. Such “first-order effects” are clearly absent in traditional linear models of the Phillips curve where the two concepts of non-accelerating inflation unemployment rate, u^* , and ‘average unemployment rate consistent with stable inflation’, $E[u_t]$, coincide.

For illustrative purposes, Figure 6.1 compares two different states of the economy, each characterised by a different degree of variability of the shocks, given a non-linear unemployment-inflation relationship denoted P. Let us assume that there exists a given inflation target, π^* , that the policymaker is able to achieve in the long run. Without shocks,

this is associated with a non-accelerating level of unemployment equal to u^* . Suppose that, under the first state, the size of the shocks hitting the economy is such that inflation rises to π_1 at time 1, whereas unemployment falls below u^* . The policymaker, in order to ensure an inflation target π^* on average, must therefore generate an inflation π_2 in the next period, thereby moving the economy to a higher unemployment rate. The average unemployment rate brought about by such shocks is labelled $E[u]$ in the figure and is necessarily larger than u^* , given the convexity of P . Let us now compare this first state of the economy with a second one, where larger shocks are assumed to periodically overheat the economy. In this event, the gap between the average level of unemployment ensuring stable inflation and the NAIRU is much larger, though the NAIRU itself is unchanged. Larger excess supply will be needed to ensure that the desired inflation rate π^* will still be achieved on average. As a result, a greater average unemployment rate, $E[u]'$, will arise.

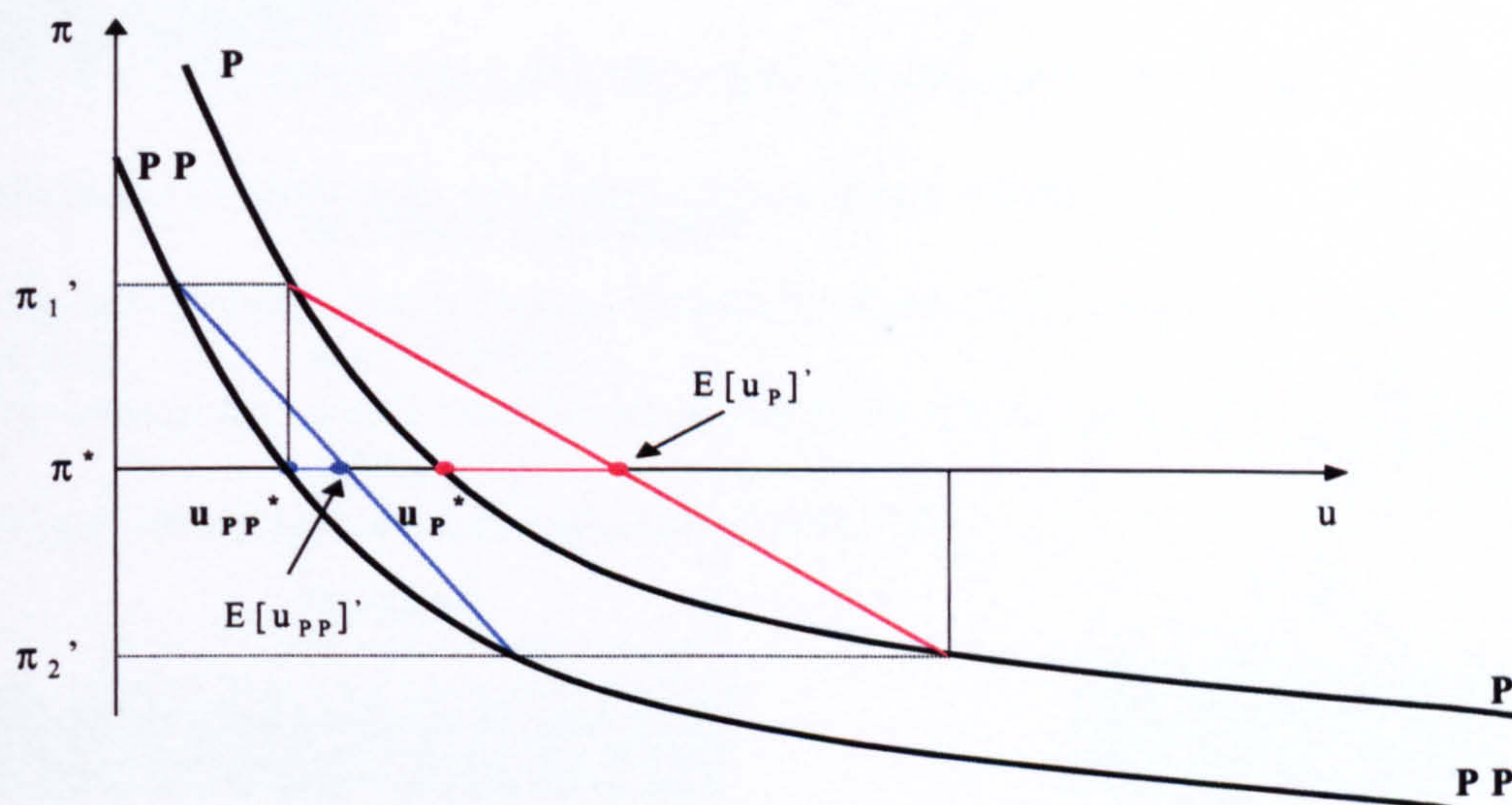
Figure 6.1 Implications of employing a non-linear model of the Phillips curve



Let us now turn to another important implication of employing a non-linear model of the Phillips and consider a shift of the curve down and to the left (figure 6.2). Such a change of position induces not only a corresponding decrease in the NAIRU (this is true in a linear context as well), but makes also the gap between $E[u]$ and u^* shrink, assuming an unchanged

variance of the shocks hitting the economy. The non-linear model is therefore suitable also to explain hysteresis effects, where the actual and equilibrium rates of unemployment co-move, though without questioning the long-run natural rate hypothesis.

Figure 6.2 Implications of a shift of the Phillips curve down and to the left



6.2.2 *Modelling alternative monetary policy regimes for Europe*

As noted above, in the basic version of MM3, only the four major European economies (i.e. Germany, France, Italy and the United Kingdom) are explicitly modelled. Nevertheless this ‘reduced notion’ of Europe, to which our attention is thereby limited, accounts for 80 per cent of total European GDP.

With respect to monetary policy, the model uses short-term nominal interest rates as monetary policy instruments for reaction functions which are consistent with either money targets, inflation targets, exchange rate targets, nominal income targets or combinations of other macroeconomic objectives, such as inflation, output and unemployment. In order to evaluate asymmetric policy impacts under different monetary policy regimes for Europe, we modify the relevant interest rate and exchange rate equations as follows.

The ERM regime

The core version of MM3 assumes that France and Italy adjust their short-term interest rates in response to movements in their exchange rates *vis-à-vis* the Deutsche Mark, whereas Germany and the United Kingdom target their money stock. The fixed exchange rate targeting featuring both French and Italian monetary policy rule is implemented by choosing an extremely large weight on deviations of their nominal exchange rate from parity, and setting feedback parameters for all other possible targets to zero. Nonetheless, current levels of national exchange rates are identically explained in terms of their expected future levels and the differential between domestic and US interest rates. Simulation results obtained with this version of the model describe country-specific macroeconomic responses under the pre-existing ERM arrangement, though excluding the UK.

Uncoordinated national monetary policies

The interest rate equations for France and Italy are firstly modified as to mimic independent (i.e. uncoordinated) national monetary policies pursuing a money target. Under this monetary set-up, France and Italy are also assumed to respond to deviation from their desired path for money balances with the same strength as Germany and the UK (by setting the relevant feedback parameter to 0.333). Their corresponding exchange rate equations are, instead, unchanged and still determined as forward-looking uncovered interest parity conditions against the US dollar.

The EMU regime

Finally, to incorporate an EMU-3 into MM3, we need to model the exchange rate equations for France and Italy as to maintain a fixed parity against the DM (standing in for the Euro, against which the DM has, in turn, a fixed value since January 1999). Thus, there are no risk premia and no possibility on reneging on the parities chosen. Employed conversion rates,

besides being the central parities of the old ERM, are also the official entry rates to EMU agreed in May 1998, at the York summit.

Furthermore, to introduce an ECB in charge of a common monetary policy, we replace the German interest rate with a common rate driven by a reaction function containing the same parameters as the old German reaction function (i.e. with a feedback parameter on deviations from money target equals to 0.333 and zero weight on any other target), but with European level variables for money supply and target money supply. These are given by the sums of their three national counterparts. Hence, short-term interest rate adjusts to accommodate deviations of the European money stock from its supply target, according to the following monetary rule:

$$rs_t = rs_{t-1} - \frac{\omega}{\mu_2} \log \left[\frac{M_t^{EMU}}{(\bar{M}_t^{EMU})} \right] \quad (6.4)$$

where ω is the feedback parameter and μ_2 is the (identical) interest elasticity of money demand in each of the EMU-3 economies.

6.3 SIMULATION RESULTS

6.3.1 Asymmetric policy responses under different monetary regimes for Europe

The existence of a non-linear Phillips curve in MM3 implies that the relative magnitude of real and nominal effects of shocks to aggregate demand depend on the sign of the shock as well as on the initial position of the economy. An increase in nominal aggregate demand induced, for example, by a change in money surplus will generate smaller short-run effects on real variables and larger short-run effects on prices, while the opposite holds in case of a deflationary shock. Such uneven response in the face of opposite shocks of the same magnitude will become even more evident if the shocks hit the economy while this is away from its steady state. Thus, if for instance the economy is already operating at potential, then a further inflationary shock would only result in higher inflation with no effect on real activity. Macroeconomic responses are also unlikely to remain unchanged under different monetary policy regimes, especially if the change in policy involves a shift from national (i.e. uncoordinated) monetary policies to a Monetary Union. To illustrate how different degrees of convexity in the short-run inflation-output trade-off interact with the choice of the monetary regime in affecting macroeconomic responses, next we contrast the effects of positive and negative money supply shocks in the four European economies under alternative monetary policy regime for Europe.

Uncoordinated national monetary policies

Table 6.2 refers to the hypothesis of uncoordinated national monetary policies. Simulations are performed in a multi-country context, thereby taking into account cross-border spillovers and second-round effects. In each country, the monetary authority targets the national money aggregate and, in the absence of any international co-ordination, decides to change permanently and unanticipatedly the target. The new target is assumed to be fully credible so that, in equilibrium, national money aggregates and prices would adjust one for one with it.

The shocks represent positive (+) and negative (-) permanent 5 percent changes in country-specific money targets starting from conditions of full-employment equilibrium. Shocks are hence applied (and the relevant model correspondingly simulated) from 2020, so that divergences across countries in policy impacts are only due to structural differences in the economies, rather than by their initial position in the business cycle. The model is further solved sufficiently far ahead, up to 2100, as to remove any influence of terminal conditions on our results.

Table 6.2 Uncoordinated national monetary targeting regimes

Germany							France						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment							Unemployment						
+	-0.704	-0.915	-0.655	-0.229	0.160	-0.399	+	-0.596	-0.855	-0.746	-0.463	-0.191	-2.787
-	0.800	1.084	0.866	0.449	0.043	1.748	-	0.674	0.997	0.919	0.626	0.316	3.616
GNP							GNP						
+	2.191	2.478	1.573	0.403	-0.566	-0.112	+	2.114	2.125	1.350	0.519	-0.014	5.685
-	-2.430	-2.871	-2.097	-0.970	0.045	-4.305	-	-2.335	-2.457	-1.723	-0.835	-0.195	-7.768
Consumption							Consumption						
+	-0.131	-0.106	0.195	0.419	0.532	0.855	+	0.083	0.135	0.299	0.308	0.235	0.780
-	0.163	0.172	-0.123	-0.361	-0.502	-1.047	-	-0.088	-0.134	-0.314	-0.343	-0.283	-1.036
Current Account							Current Account						
+	-0.404	-0.363	-0.179	0.021	0.172	-1.012	+	-0.246	-0.296	-0.209	-0.119	-0.053	-1.278
-	0.440	0.425	0.257	0.048	-0.129	1.067	-	0.260	0.335	0.255	0.154	0.070	1.438
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	0.634	1.164	1.362	1.260	0.975	4.897	+	1.273	1.426	1.067	0.602	0.251	4.874
-	-0.518	-0.967	-1.215	-1.226	-1.032	-5.132	-	-1.147	-1.307	-1.058	-0.693	-0.369	-5.118
Nominal Interest Rate							Nominal Interest Rate						
+	-1.383	-1.575	-0.956	-0.057	0.712	-0.670	+	-1.240	-1.213	-0.528	0.203	0.642	-0.896
-	1.471	1.753	1.193	0.300	-0.515	1.273	-	1.360	1.422	0.751	-0.042	-0.584	1.299
Effective Exchange Rate							Effective Exchange Rate						
+	-3.646	-2.906	-1.871	-0.982	-0.556	-	+	-3.056	-2.616	-2.154	-1.861	-1.755	-
-	4.332	3.521	2.366	1.306	0.671	-	-	3.443	2.926	2.348	1.936	1.746	-
Italy							United Kingdom						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment							Unemployment						
+	-0.256	-0.468	-0.528	-0.446	-0.294	-2.078	+	-0.568	-0.808	-0.526	-0.006	0.405	-0.900
-	0.283	0.523	0.605	0.530	0.371	2.522	-	0.652	0.993	0.770	0.228	-0.263	1.918
GNP							GNP						
+	2.807	2.899	1.714	0.279	-0.677	2.281	+	1.779	1.310	-0.071	-1.080	-1.263	-0.026
-	-3.012	-3.177	-2.034	-0.531	0.564	-3.111	-	-2.004	-1.686	-0.298	0.908	1.295	-1.133
Consumption							Consumption						
+	0.669	0.637	0.739	0.585	0.349	1.931	+	0.111	0.153	0.364	0.389	0.252	0.591
-	-0.761	-0.720	-0.832	-0.670	-0.416	-2.365	-	-0.119	-0.145	-0.376	-0.435	-0.316	-0.776
Current Account							Current Account						
+	-0.411	-0.352	-0.279	-0.182	-0.113	-2.115	+	-0.181	-0.085	0.066	0.088	0.003	-0.390
-	0.442	0.391	0.320	0.213	0.132	2.369	-	0.201	0.122	-0.046	-0.098	-0.027	0.519
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	1.469	1.438	1.100	0.683	0.325	4.903	+	1.615	2.310	1.797	0.667	-0.341	4.891
-	-1.427	-1.398	-1.103	-0.742	-0.411	-5.153	-	-1.482	-2.172	-1.897	-0.934	0.160	-5.139
Nominal Interest Rate							Nominal Interest Rate						
+	-1.181	-1.021	-0.210	0.584	0.999	0.224	+	-1.170	-0.861	0.144	0.965	1.152	0.001
-	1.281	1.167	0.341	-0.513	-1.006	-0.060	-	1.295	1.083	0.063	-0.890	-1.227	0.272
Effective Exchange Rate							Effective Exchange Rate						
+	-1.728	-1.380	-1.163	-1.244	-1.560	-	+	-2.700	-2.208	-1.979	-2.310	-2.990	-
-	1.765	1.379	1.133	1.214	1.569	-	-	2.979	2.399	2.033	2.268	2.989	-

Tables report deviations from baseline for a selection of macroeconomic indicators for the first five years of the simulation. Deviations are expressed in percentage points for GNP and effective exchange rate and in percentage points for nominal interest rates, inflation and unemployment rates. Consumption and current account balance are given in difference in proportion to baseline GNP. For all countries, the positive shocks have smaller short-run effects on real variables and larger short-run effects on nominal variables than the negative shocks. As excess demand is more inflationary than excess supply is deflationary, adjustments in the policy rates are also asymmetric: overall, in the long-run, the level of nominal interest rates is likely to be higher, as contractionary monetary responses must be stronger than expansionary policy to maintain a stable target.

Cross-country comparison shows that the effects of shocks in MM3 depend crucially on (i) the relative degrees of nominal and real rigidities existing in each country, (ii) the mechanism of expectation formation (iii) the relative size of national debt stocks. Recalling MM3 short-run inflation-output trade-off as described by the equation system (6.1)-(6.2) and its country-specific parameter estimates given in table 6.1, we note that, among European countries, the UK exhibits the highest degree of nominal and real flexibility ($\lambda_1 = 1$ and $\gamma = 2.364$, respectively). At the other extreme of the spectrum, Germany is characterised by the lowest degree of nominal flexibility ($\lambda_1 = 0.744$) and the highest degree of downward real wage resistance ($\gamma = 0.819$), closely followed by France ($\lambda_1 = 0.753$ and $\gamma = 1.137$). As a consequence, table 6.2 shows that in Germany and France monetary shocks can have large and persistent effects on real GNP and unemployment, especially if the shocks are moving the economy above their NAIRU. On the contrary, in the UK, real short-run adjustments have, *ceteris paribus*, smaller size and are fastly reversed. Hypotheses about the process of expectation formation also matter. In Italy, for instance, the low credibility of the monetary authority and the hysterical track of inflationary episodes, are assumed to have increased forward-lookingness in labour market to the maximum ($\delta_\pi = 1$). As agents learn immediately about future policy changes, price stickiness is thereby reduced and inflation responses

enhanced. Nominal interest rate adjustments, on the contrary, are the weakest in Italy, particularly in the face of deflationary shocks. High nominal flexibility coupled with timid interest rate movements imply that variations in real competitiveness are milder in Italy than in any other European economy, given an identical monetary policy change. On the opposite side is Germany, characterised by high monetary credibility and high nominal rigidities and, therefore, featuring the strongest reaction in both nominal interest rate and effective exchange rate (the latter is around 4 percent in the first year, whereas in Italy is just 1.7 percent).

Estimates of the cumulative changes in GNP and unemployment over the entire simulation horizon are also of interest, as they make visible the implications of employing a convex Phillips curve model. According to these measures, Germany features the highest degree of non-linearity, as the long-run cumulative reduction in unemployment is only 0.4 percentage points with the inflationary shock, whereas the cumulative long-run increase in the unemployment rate is over 1.7 percentage points with deflation. Non-linearities are even more evident if one considers long-run cumulative changes in GNP: a slight fall under monetary expansion versus a 4.3 percentage points reduction under monetary contraction. In any other European country, cumulative changes in real variables induced by monetary shocks of opposite sign look much more similar in magnitude, with Italy featuring the smallest degree of non-linearity. It should also be noticed that the “absolute permanent cost” of a deflation and, especially, the ‘long-run benefit’ of a surge in money supply, is much higher in France than in Germany. This is due to the slower adjustment characterising the dynamics of the unemployment gap in France ($\rho_2 = 0.44$ vs. 0.18 for Germany). As a consequence, shocks inducing persistent changes in the output gap result in correlated changes in the unemployment gap over time.

The highest impact and cumulated responses in consumption and current account balance are instead acknowledged in Italy. These are about three times as large as those in Germany and France. Explanation of such responsiveness can be found in the size of Italian government

liabilities: in an open economy where consumers excessively discount the future and count debt as net wealth, a higher level of debt stock induces, other things being equal, larger movements in disposable income, current consumption and net foreign assets in the face of an identical shock to the nominal interest rate. Yet, such large swings in GNP components are not mirrored by correspondingly large fluctuations in unemployment gap. This is because Italian labour market seems to be extremely sheltered by changes in real activity, given the low parameter estimate on the output gap featuring the Okun's law ($\rho_1 = -0.09$).

The ERM regime

Under the second scenario, France and Italy are assumed to target their exchange rates *vis-à-vis* the DM, as under the old ERM regime. Corresponding results are reported in table 6.3. With respect to these two countries, comparison between tables 2 and 3 highlights the degree to which monetary policy impacts are sensitive to the nature of the monetary policy reaction function itself. Germany and UK, instead, are largely unaffected by the switch in monetary regime, as they keep targeting their own national money stock. For these countries, discrepancies in macroeconomic responses under the first and the second monetary regime are hence only due to larger spillover effects characterising the ERM regime.

**PAGE
NUMBERING
AS ORIGINAL**

Table 6.3 The ERM monetary regime

Germany							France						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment	-0.707	-0.916	-0.653	-0.223	0.167	-0.408 +	Unemployment	-0.588	-0.838	-0.704	-0.375	-0.054	-2.499
+	0.805	1.088	0.866	0.443	0.034	1.743 -	+	0.678	1.003	0.906	0.569	0.206	3.437
GNP							GNP						
+	2.197	2.481	1.567	0.387	-0.584	-0.102 +	+	2.084	2.084	1.232	0.279	-0.362	4.939
-	-2.444	-2.883	-2.096	-0.955	0.067	-4.289 -	-	-2.351	-2.476	-1.676	-0.664	0.103	-7.304
Consumption							Consumption						
+	-0.124	-0.102	0.191	0.406	0.512	0.834 +	+	0.077	0.120	0.291	0.320	0.263	0.761
-	0.151	0.163	-0.124	-0.351	-0.483	-1.044 -	-	-0.081	-0.118	-0.306	-0.355	-0.311	-1.019
Current Account							Current Account						
+	-0.395	-0.357	-0.182	0.008	0.152	-1.008 +	+	-0.229	-0.281	-0.186	-0.079	0.003	-1.147
-	0.425	0.414	0.256	0.059	-0.109	1.058 -	-	0.246	0.327	0.241	0.123	0.022	1.316
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	0.634	1.163	1.359	1.253	0.968	4.896 +	+	1.166	1.289	0.929	0.487	0.186	4.903
-	-0.519	-0.968	-1.213	-1.220	-1.024	-5.132 -	-	-1.071	-1.204	-0.945	-0.581	-0.273	-5.141
Nominal Interest Rate							Nominal Interest Rate						
+	-1.388	-1.582	-0.958	-0.051	0.722	-0.669 +	+	-1.388	-1.582	-0.958	-0.051	0.722	-0.669
-	1.479	1.763	1.196	0.294	-0.528	1.271 -	-	1.479	1.763	1.196	0.294	-0.528	1.271
Effective Exchange Rate							Effective Exchange Rate						
+	-3.566	-2.868	-1.952	-1.218	-0.910	+ -	+	-2.787	-2.239	-1.510	-0.915	-0.655	
-	4.178	3.406	2.370	1.479	0.994		-	3.243	2.645	1.833	1.121	0.721	
Italy							United Kingdom						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment	-0.290	-0.541	-0.617	-0.512	-0.303	-2.042 +	Unemployment	-0.569	-0.808	-0.524	-0.002	0.409	-0.897
+	0.338	0.642	0.762	0.678	0.461	2.836 -	+	0.655	0.996	0.769	0.223	-0.269	1.924
GNP							GNP						
+	3.194	3.419	2.067	0.246	-1.138	2.093 +	+	1.784	1.309	-0.077	-1.088	-1.268	-0.045
-	-3.589	-3.967	-2.711	-0.801	0.836	-3.568 -	-	-2.014	-1.688	-0.292	0.919	1.302	-1.134
Consumption							Consumption						
+	0.673	0.622	0.745	0.605	0.378	1.999 +	+	0.114	0.156	0.362	0.380	0.239	0.570
-	-0.807	-0.737	-0.873	-0.719	-0.467	-2.529 -	-	-0.125	-0.150	-0.376	-0.428	-0.303	-0.767
Current Account							Current Account						
+	-0.496	-0.404	-0.276	-0.121	-0.020	-2.252 +	+	-0.176	-0.084	0.060	0.077	-0.009	-0.382
-	0.572	0.491	0.356	0.173	0.037	2.609 -	-	0.192	0.117	-0.042	-0.087	-0.013	0.508
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	1.531	1.481	1.081	0.581	0.162	4.876 +	+	1.614	2.306	1.790	0.660	-0.344	4.891
-	-1.511	-1.461	-1.106	-0.667	-0.258	-5.107 -	-	-1.483	-2.171	-1.892	-0.925	0.168	-5.139
Nominal Interest Rate							Nominal Interest Rate						
+	-1.388	-1.582	-0.958	-0.051	0.722	-0.669 +	+	-1.174	-0.867	0.138	0.961	1.151	0.003
-	1.479	1.763	1.196	0.294	-0.528	1.271 -	-	1.299	1.089	0.068	-0.888	-1.226	0.270
Effective Exchange Rate							Effective Exchange Rate						
+	-2.569	-2.060	-1.390	-0.852	-0.623	+ -	+	-2.650	-2.189	-2.044	-2.476	-3.226	
-	2.980	2.428	1.683	1.037	0.683		-	2.884	2.332	2.051	2.401	3.221	

Under uncoordinated and independent national monetary policy, where France and Italy were assumed to target money supply, the short-run effects of the shock are considerably smaller and the economy returns to potential much faster. The ERM regime is characterised by the fact that the Bundesbank (i.e. Germany) acts as a Stackelberg leader in Euroland, with France and Italy acting as followers. An exchange rate targeting implies that nominal interest rates in these two countries are moving in line with the German policy rate which, in turn, is adjusting to accommodate *national* monetary unbalances. French and Italian domestic economic circumstances, instead, do not matter. Yet, since Germany is characterised by a higher degree of nominal rigidities than other ERM members, it also requires comparatively higher interest rate movements in the face of an identical monetary shock. Under exchange rate targeting, these larger policy changes translate into the Italian and French economies, irrespective of their labour market/economy structures or fiscal stances. As a result, short- and long-run policy impacts on nominal variables appear to be marginally greater under ERM than under uncoordinated money targeting regimes for both France and Italy. On the other hand, however, real effects differ quite significantly in the two countries. Whereas in Italy greater nominal responses translate into larger fluctuations in GNP components, in France these are smaller. Once again, explanation is likely to be found in the dissimilar budgetary positions characterising the two economies. On the ground of these results, we can hence conclude that a switch to an exchange rate targeting is liable of enhancement not only in the magnitude of monetary responses, but also in the degree of asymmetry across European economies.

The EMU regime

Finally, table 6.4 illustrates country-specific responses to a common shock to the European monetary aggregate, under the assumption of existence of a Monetary Union among Germany, France and Italy. This is certainly the most interesting scenario, as it allows us to evaluate whether the presence of a Monetary Union will exacerbate or lessen cross-country

spillovers and divergences in policy responses. As far as the former are concerned, as European economies will no longer be exposed to the whims of (intra-EMU) nominal exchange rate fluctuations. As Europe becomes more similar to a closed economy, cross-border spillovers are then likely to be internalised in monetary policy-making. At the same time, the advent of EMU implies a different institutional setting in the field of monetary policy. As NCB's now collectively determine monetary policy for Euroland in the Governing Council of the ECB as a unique authority, a Monetary Union automatically induces international monetary policy co-ordination. This means that also monetary policy externalities in the face of symmetric nominal shocks are eliminated. As a consequence, the effects of identical monetary shocks on both interest rate and effective exchange rate are likely to be reduced under EMU. This can be verified by juxtaposing the corresponding responses in Germany, France and Italy under EMU and under ERM (table 6.3 vs. table 6.4). This seems to confirm the findings according to which the creation of EMU mitigates the reaction of central bank to economic shocks, as a result of policy co-ordination (Cavelaars, 1999). Furthermore, one should note that, under the new monetary regime, not only macroeconomic responses are found to be smaller but also cross-country asymmetries look reduced. With respect to the old ERM, the creation of a Economic and Monetary Union should then be viewed as an improvement for the Euro-zone as a whole. Comparison with the outcomes obtained under uncoordinated monetary policies (table 6.4 vs. table 6.2) is, instead, less clear-cut. EMU can certainly still be regarded as the most desirable monetary arrangement for France and (even more) for Germany, also when compared with shocks' responses under individual national monetary stances. For these two countries, policy adjustments are likely to be smaller and more homogeneous under a Monetary Union than under uncoordinated monetary policies. *Ceteris paribus*, EMU happens to reduce long-term costs of both inflationary and deflationary policies in terms of cumulated unemployment and output responses with respect to these economies. In this way, the degree of cross-country heterogeneity becomes less evident even in the absence of any labour market reform. However, this is not the case for Italy. Italy appears to be better off under an independent

national monetary policy, given the implicit assumption of perfect credibility of its monetary authority. This is because, for Italy, the internalisation of cross-border spillover due to the advent of EMU does not compensate for the lack of an independent interest rate adjustment mechanism: under EMU responses are too large. To see why, it should be recalled that Italy is characterised by a large degree of nominal flexibility (i.e. large responses to inflation expectations). Monetary expansions and contractions result here in smaller and less persistent business cycle, as prices are less sticky. Consequently, interest rates would need not to move as much as elsewhere. Having a common monetary policy implies, for Italy, facing monetary responses larger than in the uncoordinated regime. Given the convexity of the inflation-output trade-offs, in MM3 stronger policy adjustments are always more costly (i.e. undesirable) because of the declining marginal effectiveness of large output gaps in reducing inflation, on the one hand, and large inflationary pressures in reducing employment slacks, on the other hand. Yet, given the relevance of its public debt stock, these costs are further enhanced for Italy. One should then conclude that, as the strength of interest rate responses is found to decrease for rigid economies while it is likely to increase where price are less sticky, EMU does not appear to favour European convergence. Ultimately, different degrees of (nominal) rigidity in country-specific inflation-output relationships are a sufficient condition to undermine synchronisation in the business cycle of European economies given a common monetary policy. Before questioning whether widespread labour market flexibility could on its own ensure convergence across European economies, we investigate the effects of engaging in a Monetary Union when initial conditions differ from steady state.

**PAGE
NUMBERING
AS ORIGINAL**

Table 6.4 The EMU monetary regime

<i>Germany</i>							<i>France</i>						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment							Unemployment						
+	-0.679	-0.882	-0.641	-0.253	0.094	-0.323 +		-0.564	-0.801	-0.677	-0.380	-0.097	-2.563
-	0.759	1.022	0.817	0.439	0.083	1.622 -		0.638	0.937	0.841	0.535	0.217	3.332
GNP							GNP						
+	2.112	2.386	1.545	0.485	-0.379	-0.304 +		1.998	1.986	1.189	0.330	-0.219	5.143
-	-2.306	-2.707	-1.980	-0.964	-0.081	-3.938 -		-2.213	-2.302	-1.545	-0.634	0.018	-7.081
Consumption							Consumption						
+	-0.116	-0.094	0.181	0.379	0.477	0.838 +		0.083	0.128	0.288	0.307	0.241	0.741
-	0.138	0.147	-0.120	-0.325	-0.442	-1.028 -		-0.089	-0.130	-0.305	-0.340	-0.286	-0.985
Current Account							Current Account						
+	-0.378	-0.344	-0.186	-0.016	0.115	-0.992 +		-0.217	-0.265	-0.176	-0.081	-0.012	-1.140
-	0.399	0.389	0.246	0.074	-0.073	1.012 -		0.230	0.301	0.220	0.115	0.030	1.275
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	0.617	1.139	1.355	1.289	1.046	4.844 +		1.159	1.292	0.957	0.539	0.243	4.944
-	-0.503	-0.943	-1.198	-1.237	-1.091	-5.108 -		-1.065	-1.208	-0.968	-0.627	-0.336	-5.179
Nominal Interest Rate							Nominal Interest Rate						
+	-1.301	-1.356	-0.672	0.165	0.772	-0.385 +		-1.301	-1.356	-0.672	0.165	0.772	-0.385
-	1.396	1.522	0.864	0.002	-0.669	0.796 -		1.396	1.522	0.864	0.002	-0.669	0.796
Effective Exchange Rate							Effective Exchange Rate						
+	-3.402	-2.757	-1.984	-1.439	-1.279	+ -		-2.654	-2.148	-1.536	-1.094	-0.953	
-	3.892	3.171	2.292	1.623	1.342			3.014	2.457	1.771	1.237	1.001	
<i>Italy</i>							<i>United Kingdom</i>						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment							Unemployment						
+	-0.280	-0.520	-0.594	-0.501	-0.313	-2.084 +		-0.568	-0.807	-0.526	-0.006	0.405	-0.901
-	0.319	0.603	0.712	0.635	0.441	2.745 -		0.652	0.992	0.769	0.227	-0.263	1.918
GNP							GNP						
+	3.081	3.272	1.991	0.312	-0.928	2.320 +		1.780	1.308	-0.071	-1.080	-1.263	-0.038
-	-3.395	-3.707	-2.506	-0.752	0.691	-3.529 -		-2.005	-1.683	-0.297	0.908	1.295	-1.118
Consumption							Consumption						
+	0.671	0.630	0.751	0.607	0.377	1.988 +		0.106	0.152	0.364	0.391	0.254	0.574
-	-0.784	-0.728	-0.861	-0.707	-0.457	-2.468 -		-0.112	-0.141	-0.374	-0.435	-0.318	-0.755
Current Account							Current Account						
+	-0.480	-0.395	-0.280	-0.140	-0.046	-2.230 +		-0.183	-0.086	0.064	0.087	0.002	-0.385
-	0.542	0.466	0.346	0.182	0.062	2.548 -		0.203	0.124	-0.044	-0.098	-0.027	0.513
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	1.529	1.486	1.105	0.626	0.218	4.928 +		1.614	2.308	1.796	0.666	-0.342	4.895
-	-1.495	-1.453	-1.118	-0.704	-0.317	-5.155 -		-1.482	-2.172	-1.896	-0.933	0.160	-5.143
Nominal Interest Rate							Nominal Interest Rate						
+	-1.301	-1.356	-0.672	0.165	0.772	-0.385 +		-1.168	-0.860	0.142	0.960	1.146	0.010
-	1.396	1.522	0.864	0.002	-0.669	0.796 -		1.291	1.079	0.062	-0.887	-1.221	0.260
Effective Exchange Rate							Effective Exchange Rate						
+	-2.448	-1.978	-1.415	-1.015	-0.895	+ -		-2.751	-2.258	-2.026	-2.349	-3.019	
-	2.772	2.257	1.627	1.143	0.937			3.048	2.465	2.091	2.311	3.015	

6.3.2 *Do initial conditions matter?*

While previous results are obtained under the assumption that all economies are starting from equilibrium conditions, we now proceed by withdrawing such hypothesis. With respect to the EMU scenario, we consider the same permanent positive and negative changes to the European aggregate money target as in the previous section, though the model is shocked and simulated starting from year 2001. At that date, effects of business cycle variations are still relevant, as none of the economies has reached its steady-state position yet. On the basis of MM3 baseline forecasts (not reported), we note that in 2001 Euroland is assumed to be largely below potential with country-specific unemployment rates around one percentage point above their respective natural rates. Monetary conditions are overall loose to foster demand recovery, with money growth rates above equilibrium and interest rates well below their steady-state values. Despite that, price inflation rates persist in being some 1 percentage point below their equilibrium level. Outside Euroland, the UK economy is instead presumed to be characterised by excess of demand conditions, with unemployment more than 1 percentage point below its corresponding deterministic NAIRU. British monetary stance, in turn, comes close to its steady state already in 2001.

Results of the simulation experiment are summarised in table 6.5. As already seen before, the convexity characterising the Phillips curve model implies that common monetary shocks of the same magnitude but with opposite sign induce uneven macroeconomic responses. These nonlinearities become more evident if the shocks hit the economy while this is away from its steady state (compare table 6.4). Thus, in the case of the UK economy, which is operating close to potential and above its NAIRU, inflationary shocks result in higher inflation with smaller effects on unemployment and GNP. Price flexibility, which is an intrinsic feature of the UK inflation-output trade-off, is therefore enhanced under full employment conditions. Conversely, in the case of Germany, France and Italy, all characterised by excess of supply conditions, inflation is less sensitive to surges in money surplus than in steady state; short-

run effects on unemployment and real output appear, instead, correspondingly larger in the face of an identical deflationary shock. Unemployment impact responses in Italy represent, once more, an exception, as they hardly vary with demand conditions; however, general conclusions remain valid with respect to its cumulated responses. Summarising, real rigidities are expected to be reinforced by slumps in demand.

As rigid labour markets become more rigid, while flexible ones tend to gain further nominal responsiveness, extant economic conditions are likely to represent weighty barriers to the process towards convergence within Europe as a whole. Limiting our attention within Euroland, things do not look much better, as both inflationary and deflationary adjustments are magnified, making cross-country asymmetries in monetary responses more visible.

**PAGE
NUMBERING
AS ORIGINAL**

Table 6.5: The EMU monetary regime under disequilibrium conditions

<i>Germany</i>							<i>France</i>						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment	-0.742	-0.991	-0.770	-0.399	-0.047	-0.726 +	Unemployment	-0.640	-0.932	-0.823	-0.533	-0.238	-3.361
+	0.831	1.148	0.965	0.612	0.260	2.412 -	+	0.729	1.096	1.019	0.725	0.397	4.391
GNP							GNP						
+	2.308	2.707	1.906	0.894	0.008	0.917 +	+	2.261	2.338	1.518	0.669	0.067	7.273
-	-2.520	-3.057	-2.376	-1.438	-0.567	-6.777 -	-	-2.511	-2.715	-1.933	-1.049	-0.354	-9.986
Consumption							Consumption						
+	-0.059	-0.076	0.143	0.340	0.457	0.965 +	+	0.164	0.166	0.247	0.279	0.238	0.920
-	0.071	0.122	-0.073	-0.271	-0.405	-1.282 -	-	-0.183	-0.177	-0.255	-0.304	-0.281	-1.263
Current Account							Current Account						
+	-0.455	-0.419	-0.233	-0.050	0.096	-1.293 +	+	-0.280	-0.318	-0.212	-0.105	-0.025	-1.471
-	0.480	0.473	0.299	0.116	-0.045	1.314 -	-	0.298	0.369	0.265	0.148	0.049	1.678
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	0.505	1.002	1.232	1.243	1.091	4.814 +	+	0.970	1.153	0.867	0.569	0.337	4.916
-	-0.391	-0.778	-1.026	-1.128	-1.085	-5.069 -	-	-0.844	-1.014	-0.852	-0.639	-0.436	-5.161
Nominal Interest Rate							Nominal Interest Rate						
+	-1.339	-1.415	-0.779	0.013	0.606	-0.815 +	+	-1.339	-1.415	-0.779	0.013	0.606	-0.815
-	1.443	1.602	0.994	0.179	-0.476	1.300 -	-	1.443	1.602	0.994	0.179	-0.476	1.300
Effective Exchange Rate							Effective Exchange Rate						
+	-3.720	-3.027	-2.171	-1.515	-1.234	-	+	-2.915	-2.369	-1.684	-1.147	-0.906	-
-	4.300	3.521	2.536	1.729	1.297		-	3.343	2.739	1.963	1.313	0.953	
<i>Italy</i>							<i>United Kingdom</i>						
	Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated		Year 1	Year 2	Year 3	Year 4	Year 5	Cumulated
Unemployment	-0.312	-0.582	-0.688	-0.615	-0.430	-2.596 +	Unemployment	-0.497	-0.621	-0.282	0.200	0.492	-0.381
+	0.357	0.681	0.831	0.782	0.597	3.500 -	+	0.581	0.798	0.496	-0.028	-0.401	1.247
GNP							GNP						
+	3.427	3.710	2.508	0.776	-0.613	3.236 +	+	1.554	0.873	-0.434	-1.204	-1.108	-1.017
-	-3.789	-4.227	-3.132	-1.359	0.225	-5.156 -	-	-1.786	-1.237	0.136	1.125	1.188	-0.041
Consumption							Consumption						
+	0.822	0.747	0.842	0.659	0.406	2.157 +	+	0.187	0.285	0.466	0.404	0.193	0.641
-	-0.968	-0.870	-0.974	-0.776	-0.502	-2.790 -	-	-0.195	-0.279	-0.498	-0.468	-0.266	-0.883
Current Account							Current Account						
+	-0.549	-0.481	-0.327	-0.152	-0.033	-2.560 +	+	-0.141	-0.012	0.078	0.040	-0.086	-0.433
-	0.624	0.573	0.409	0.204	0.052	2.954 -	-	0.162	0.044	-0.070	-0.059	0.065	0.589
Inflation (GNP deflator)							Inflation (GNP deflator)						
+	1.448	1.454	1.047	0.652	0.287	4.889 +	+	2.058	2.623	1.575	0.208	-0.736	4.886
-	-1.373	-1.376	-1.049	-0.724	-0.398	-5.130 -	-	-1.908	-2.540	-1.781	-0.470	0.653	-5.136
Nominal Interest Rate							Nominal Interest Rate						
+	-1.339	-1.415	-0.779	0.013	0.606	-0.815 +	+	-1.052	-0.586	0.412	1.049	0.997	0.199
-	1.443	1.602	0.994	0.179	-0.476	1.300 -	-	1.185	0.804	-0.251	-1.038	-1.103	0.049
Effective Exchange Rate							Effective Exchange Rate						
+	-2.684	-2.178	-1.550	-1.065	-0.855	-	+	-2.426	-2.063	-2.113	-2.724	-3.522	-
-	3.069	2.511	1.802	1.215	0.897		-	2.658	2.206	2.132	2.708	3.628	

6.3.3 *Increasing flexibility in European labour markets: winners and losers*

'Reform' and 'flexibility' for European labour markets are increasingly preached by economists as much as by policy-makers. The consensus, in this respect, is generally unanimous. The 'dotcom summit' in Lisbon represents the newest commitment of EU's leaders to engage in structural institutional reforms to favour micro-economic flexibility. The logic of the recommended approach sounds clear: 'changes in the law and greater mobility are crucial to erode unemployment' (Financial Times, March 2000). At aggregate Euro-zone level, the picture is indeed bleak, with 12.4m currently unemployed, only 61 percent of the working age population in work, 5 percent of workforce out of work for over a year. The challenge is hard, as European countries have to struggle with overpricing, severe lack of mobility of unskilled labour, limited wage flexibility, high taxation on employment and the sheer cost of firing workers, which serves to deter employers from hiring in the first place. However, whereas the EU possesses collective instruments for enhancing competition and market integration, labour market and welfare policies are and remain national, with striking differences across member states.

In France unemployment fell sharply to 10.2 percent in February 2000 and is at its lowest level since 1992. The number of long-term jobless is falling, vacancies are at their highest for a decade and service sector employment has grown at an annual rate of 3.9 percent last year. These successes can be attributed to practices such as the maximum 35-hour working week and retraining programmes for those out of work. The removal of restrictions on the use of fixed-term contracts and part-time workers tends to have a significant impact on employment rates in the service sector. In the Netherlands, where part-time workers make up 30 percent of the labour force, the jobless rate is about 3 percent, even lower than in the US. In Italy too part-time and temporary jobs are becoming more common. However, unemployment remains high (11.4 percent) due to the disencouraging Italian labour regulation, which inhibits employers from reducing workforce during slumps. In Germany

employment is stifled by the centralisation of wage bargaining. Wages are set in accordance with sector-wide agreements between trade-unions and employers' associations. Such system deprives company of the ability to pay wages which best suit individual circumstances. Outside Euroland, the UK has witnessed much of the change in labour market flexibility as a result of changes in legislation in the 1980s. In particular, a number of laws were passed that reduced the costs to employers of making wages and employment adjustments, such as the abolition of minimum wage, the weakening of the power of trade unions, the lowering of both hiring and firing costs, the increase in temporary employment. Millard (2000) compares the *ex-post* effects of such increase in UK labour market flexibility with the predictions of a real business cycle model and a search model. He finds that actual data 'tentatively support' the models' predictions as for greater output, consumption and employment and lower average hours. Nonetheless, *volatilities* of output, consumption, employment and hours have all increased since 1988, contrary to theoretical predictions.

Among the studies supporting the 'flexible-is-good' position, stands out the chapter on EMU in the IMF's World Economic Outlook (1997). According to it, labour market reform is sufficient to produce the desirable outcomes of lower equilibrium unemployment and higher growth, *hence* favouring fiscal restructuring. This conclusion is drawn from a simulation exercise on MM3, where increased labour market flexibility is captured through an increase in the parameter on unemployment (γ in (6.2)) by around 1/3 of its value, while an increase in the weight λ_1 captures a reduction in the inertia of the inflation process. Further to this, labour-market reform is assumed to imply that (i) government expenditures are permanently reduced at 2 percentage points below baseline from the fourth year of the simulation, leading to lower debt levels and (ii) total factor productivity is permanently increased by 0.5 percent above the baseline from the second year of the simulation. As a result of such shocks, the natural rate falls by 2 percentage points, the Phillips curve shifts down and to the left and becomes steeper, while the gap between the average and the natural rate of unemployment shrinks (see figure 6.2). In our view, the simulation fails to provide any evidence in favour of

labour-market reform, inasmuch as the benign effects are mainly driven by other factors but structural changes in the labour market. The causal link seems indeed to work the other way round: a sustained shock in productivity coupled with robust fiscal consolidations is sufficient, in the presence of departures from Ricardian equivalence, to boost real growth in steady-state and to lower interest rate levels. The corresponding fall in the equilibrium rate of unemployment will *then* result in an endogenous gain in flexibility, because of the non-linearity of the Phillips curve model employed (see section 6.2.1).

Below we aim to assess the effects of changes in the degree of nominal and real flexibility in European labour markets in the face of a common 5 percent increase in the aggregate money target. This is done by rendering country-specific labour markets' parameterisations all the same, while maintaining unchanged any other singularity characterising the monetary transmission mechanism. We thus evaluate the contribution made by each parameter estimate in the inflation-output nexus (i.e. the degree of nominal and real rigidities, the degree of persistence in the Okun's law and the position of the unemployment wall) to the degree of divergence in national GNP responses. As a benchmark we take the UK Phillips curve model, for it features the highest degree of nominal and real wage flexibility, alongside high credibility in monetary policy (recall parameter estimates in table 6.1). Figure 6.3 reports the effects on real GNP for Germany and Italy, where differences are more striking. Bars indicate GNP responses under the original model parameterisation, whereas lines denote responses after sequential modifications.

The top panel only assumes the degree of nominal flexibility to be the same in both countries as in the UK, by making corresponding λ_1 and δ_π parameters in equation (6.2) identical. The second panel, in addition to the previous assumption, also implies an analogous degree of real rigidities. This is done by altering the value of γ in (6.2) UK-wise. The third panel takes into account also the parameterisation of the corresponding Okun's laws, that is it assumes ρ_1 and ρ_2 in (6.1) to be the same in all countries. Finally, in the bottom panel, the position and degree of curvature of the models also become identical through proper modification of

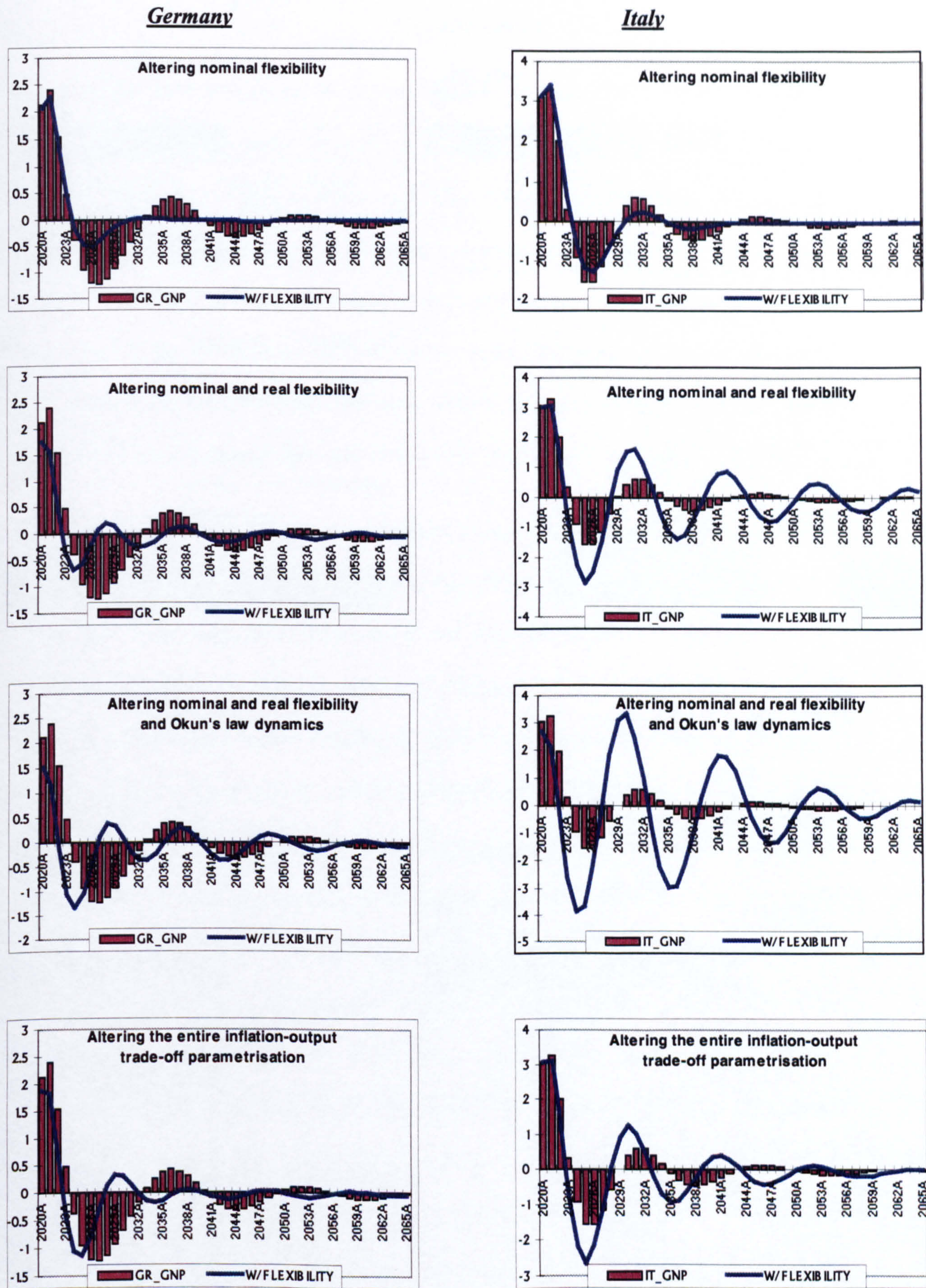
the natural rate of unemployment, u^* , and corresponding unemployment floor, ϕ , in (6.2), both regarded as exogenous variables in the model. In this way, German and Italian labour markets are forced to exhibit the same features as the most flexible European counterpart.

Comparison of German and Italian GNP responses under original parameterisation shows that for a country like Italy, characterised by a weighty stock of public debt, the output responsiveness to monetary shocks is greater than elsewhere, *ceteris paribus*, owing to the existence of a forward-looking closure fiscal closure rule in the model. Under these circumstances, results suggest that allowing for greater (nominal and real) flexibility in the labour market may have undesirable consequences. In particular, the first panel of figure 6.3 shows that an increase in *nominal flexibility* in Germany (where λ_1 moves from 0.744 to 1) produces the same qualitative effects of an overall increase in *nominal rigidity* in Italy (where λ_1 is increased by 0.088 but δ_π is reduced from 1 to 0.53 owing to the gain in credibility under the new monetary authority). In both cases, short-run adjustments to the inflationary shock become smaller and smoother (though the beneficial effect is more pronounced in Germany). What about *real* flexibility? Since a higher degree of real flexibility implies a greater inflation responsiveness to output and unemployment conditions, the second panel shows that structural reforms of the labour market which are not preceded by fiscal consolidation may actually have destabilising effects in the Italian economy. With respect to Italy, we hence find support to Burda's (1999) conclusion that '[c]alls for additional flexibility may be the economic equivalent of whipping a dead horse, and could provoke counterproductive reactions'. These results seem also be able to explain Millard's (2000) findings, according to which an increase in labour market flexibility is likely to boost volatility of real aggregates. However, things are really different for Germany. Here an enhancement in real flexibility is found to reduce both the immediate effects on GNP of the expansionary monetary shock and their persistence, while bringing about only a tolerable amount of cyclicity.

Speeding up the dynamics in the translation of output gaps into unemployment gaps is, instead, unlikely to be worthwhile to any extent (third panel). It actually brings about a slight reduction in the immediate GNP response in Germany, but at the expense of further booms and busts. In Italy, such undesirable surge in output volatility is strikingly magnified, as it opens up a spiral of output-unemployment gaps fluctuations which was originally closed off.

Analysis of the bottom panel carries out further implications of great interest for economic policy. The only difference between the third and the fourth panel is due to a change in the position of the curve and, thereby, in the NAIRU. This is *per se* able to bring back fluctuations to a reasonable amount even in Italy, where the counterproductive effects of imposing a higher degree of real flexibility in the inflation-output nexus are manifest. This means that both the ordering and the type matter, while talking about labour market "reforms". Proceeding to fiscal consolidation seems in fact *conditio sine qua non* to boost real growth in steady-state, lower interest rate levels and curb real short-run adjustments to monetary shocks, especially in the presence of departures from Ricardian equivalence. An higher level of resources in the economy should in this way favour structural labour market reforms aiming at reducing the natural rate of unemployment. They mainly presume cuts in tax wedge components as well as retrenchments in other exogenous wage-push factors, like the replacement ratio (see appendix). Reductions in the Non- Accelerating Inflation Rate of Unemployment, by shifting the Phillips curve down and to the left, are likely to induce automatically a surge in flexibility. Whether further real and/or nominal flexibility in the labour market needs to be enhanced by law remains ultimately a national matter, as no *one-fits-all* formula seems to apply.

Figure 6.3 Implications of increasing flexibility in German and Italian labour markets
GNP responses to a 5 percent increase in aggregate money target under EMU*



* In percentage changes from baseline.

6.4 CONCLUDING REMARKS

In this chapter we examined the interaction between monetary policy regimes and labour market structures in European countries. While providing further model-based evidence about the effects of embracing a common monetary stance when underlying macroeconomic structures still differ across countries, we tried to answer a number of relevant questions. Is the choice of which institutional monetary arrangement neutral with respect to cross-country divergences in the real economies? Can labour market flexibility correct for asymmetric policy responses thereby favouring convergence across European countries? Is labour market flexibility always good news? The answer is found to be negative in all cases.

First of all, we note that natural rate considerations are out of place when the choice of a monetary regime is at question. As inertia in the inflation process is substantial, monetary policy shapes real aggregates responses in the short-to-medium run. Moreover, if the inflation-output nexus is likely to exhibit non-linearities, then monetary policy can also affect the average level of real variables in equilibrium. Sensitivity analysis to alternative (uncoordinated vs. co-ordinated) monetary designs for Europe shows that, under EMU, cross-border exchange-rate fluctuations are to be internalised and monetary co-operation institutionally enforced. On this ground, the overall sensitivity to common monetary shocks is found to be weaker under EMU than under any alternative monetary regime for Europe. This would render the degree of cross-country heterogeneity less evident, even in the absence of any active labour reform. While this is undeniable with respect to those European countries exhibiting stronger rigidity in their economic structure, it is not true for countries characterised by higher price and real output responsiveness. For these countries, EMU remains desirable if compared with the old ERM regime, but still features policy overreaction in the face of symmetric monetary shocks. Although conclusions are far from being indisputable, our results seem to suggest that a Monetary Union is likely to render

rigid economies more similar to one another, while widening the gap between rigid and flexible economies within Euroland. Different extant economic conditions are also likely to represent weighty barriers to the process towards convergence.

In the presence of non-linear short-run constraints, different degrees of rigidity in country-specific inflation-output relationships are hence found sufficient to generate asymmetries in the business cycle under EMU. Conversely, labour market discipline is not able to ensure convergence on its own. In particular, responsiveness to monetary changes is significantly greater - *ceteris paribus* - in high-debt countries. The chapter argues that in these cases, allowing for greater nominal and real flexibility in the labour market may actually induce destabilising effects in the economy. This seems to suggest a clear ordering in the sequence of structural reforms these countries need to undertake.

APPENDIX

Extending Clark and Laxton (1997) and Laxton *et al.* (1998), in this appendix we briefly recap how a 'semi-reduced-form' Phillips Curve can be derived from a wage- and price-setting framework and which are the features of the labour and good markets that may possibly underly its convexity.

The Phillips curve model can be thought of as an adjustment mechanism embodied within the Layard and Nickell (1985, 1986) imperfect competition approach¹. Their approach uses the wage-price system to determine the core supply side of the economy, which is seen to arise as the long-run solution to the wage and price equations. This can then be employed to derive an expression for the Non-Accelerating Inflation Rate of Unemployment (NAIRU), given conditions such as static homogeneity.

Specifically, workers are assumed to seek a given real consumption wage that satisfies their aspirations, whereas firms are seeking to achieve a given mark-up over costs. These competing claims may not be consistent. Only when unemployment is at its equilibrium level, competing claims are reconciled and inflation is stable. The wage- and price-setting can thus be characterised as follows:

$$w = p^e + pr + \alpha_0 - \alpha_1 u - \alpha_2 te - \alpha_3 tl + \alpha_4 td + \alpha_5 \rho + \alpha_6 z^w \quad (\text{A.1})$$

$$pp = \beta_0 - \beta_1 u + (1 - \beta_2)(w + te - pr) + \beta_2 m \quad (\text{A.2})$$

¹ An excellent account of the economics of the labour market models, including the Layard-Nickell approach, is given in Carlin and Soskice (1990). For an analysis of the core supply-side framework in an open-economy context see Joyce and Wren-Lewis (1991), Turner (1991), Wren-Lewis (1997). Wallis (1993) provides useful discussion on real wage resistance assumptions, whereas Graafland (1992) and Huizinga *et al.* (1998) investigate their empirical relevance for models of the Dutch economy.

Equation (A.1) specifies real consumption wage in terms of expected consumer price (pe). It moves in line with productivity (pr) and is a negative function of unemployment (u), employers' payroll (te) and indirect taxes (ti); conversely, unions' real-wage claims increase with direct taxation (td), real exchange rate (ρ) and other exogenous wage-push factors (z^w), such as unemployment benefits and trade union power. The producer price equation (A.2) is a mark-up on real wage costs and import costs, with an allowance that the mark-up rises with demand pressure (and falls with demand slack, proxied by u). We can re-write this as:

$$(1 - \beta_2)pp = \beta_0 - \beta_1 u + (1 - \beta_2)(w + te - pr) + \beta_2(m - pp)$$

This yields:

$$pp = \delta_0 - \delta_1 u + (w + te - pr) + \delta_2 \rho \quad (\text{A.3})$$

where $\delta_0 = \beta_0 / (1 - \beta_2)$, $\delta_1 = \beta_1 / (1 - \beta_2)$ and $\rho = (m - pp)$. Furthermore, given the identity linking consumer prices to producer prices, $p = pp + ti$, we can re-write the wage-price system (A.1)-(A.2) as follows:

$$w - p^e - pr = \alpha_0 - \alpha_1 u - \alpha_2 te - \alpha_3 ti + \alpha_4 td + \alpha_5 \rho + \alpha_6 z^w \quad (\text{A.4})$$

$$p - w + pr = \delta_0 - \delta_1 u + te + ti + \delta_2 \rho \quad (\text{A.5})$$

In expectational equilibrium with non-accelerating inflation (i.e. $\Delta\pi = 0$), solution of (A.4)-(A.5) determines the NAIRU as a function of tax variables, real exchange rate and other wage-push factors. Changes in the level of productivity, on the contrary, leave unemployment unchanged in the long run, under the assumption that permanent shifts in productivity are reflected in identical shifts in the equilibrium real wage (that is, under static homogeneity).

$$u^* = \frac{1}{\alpha_1 + \delta_1} [(\alpha_0 + \delta_0) + (1 - \alpha_2)te + (1 - \alpha_3)ti + \alpha_4 td + (\alpha_5 + \delta_2)\rho + \alpha_6 z^w] \quad (\text{A.6})$$

Consider (A.5) as defining the equilibrium (or target) price level, \bar{p} . Using (A.6), we can therefore express the price-wage system (A.4)-(A.5) as defining the short-term trade-off between deviations of the expected price level from its equilibrium level and the unemployment gap, namely:

$$(p^e - \bar{p}) = (\alpha_1 + \delta_1)(u - u^*) \quad (\text{A.7})$$

(A.7) represents the 'reconciliation mechanism' of competing claims. It states that when u is above u^* , then firms are setting 'too low' prices (i.e. real wage costs are too high) so that prices are expected to rise in the future to reconcile firms' and unions' real claims; the opposite holds true when u is below its equilibrium rate. Note that in (A.7) the equilibrium rate of unemployment is endogenously determined by the solution of the implicit wage-price system described above: as a result, changes in any of the factors entering (A.6) are implicitly affecting the NAIRU. Yet, under the assumption that the actual price level adjusts only gradually to the target price level, it is possible to introduce a dynamic price adjustment in an error correction form such that:

$$\Delta p_t = \lambda_1 (\bar{p} - p_{t-1}) + \lambda_2 \Delta p_{t-1} \quad (\text{A.8})$$

Allowing for λ_2 to be different from zero introduces inertia in the inflation process and not only in prices. Under the further assumption that $\lambda_1 + \lambda_2 = 1$, equation (A.8) actually translates into an error correction for inflation rather than the price level. This becomes clear by letting $\bar{p} - p_{t-1} = \bar{\pi}$ and subtracting $\lambda_1 \pi_{t-1}$ from both sides of equation (A.8), such that:

$$\Delta \pi_t = \lambda_1 (\bar{\pi} - \pi_{t-1}) \quad (\text{A.9})$$

Denote $p^e - p_{t-1} = \pi^e$; with few algebraic transformations, the two-equation system (A.7)-(A.9) can now be solved to derive a linear expectations-augmented Phillips curve model which summarises the implicit inflation-unemployment nexus:

$$\pi_t = \lambda_1 \pi^e + (1 - \lambda_1) \pi_{t-1} + \lambda_1 (\alpha_1 + \delta_1) (u^* - u) \quad (\text{A.10})$$

Note that in equilibrium, the inflation rate is constant and the unemployment rate u coincides with the equilibrium unemployment rate u^* .

In equation (A.10) the responsiveness of π to π^e , as measured by λ_1 , can be regarded as the degree of nominal flexibility. The coefficient on the unemployment reflects both the degree of nominal flexibility and the degree of real rigidity, the latter expressed by $1/(\alpha_1 + \delta_1)$, as discussed in Layard *et al.* (1991). The degree of real rigidity is high when prices and wages are not responding much to variations in demand conditions (i.e. to unemployment level): in this case α_1 and δ_1 are small while $1/(\alpha_1 + \delta_1)$ is large. Incidentally, it should be noticed that the higher real rigidity, the larger is the NAIRU, other things being equal, as it is evident from equation (A.6). Moreover, the interaction between the degree of nominal and (the inverse of) real rigidity determines the slope of the linear Phillips curve, reflecting a constant short-run trade-off between inflation and unemployment gap. A higher degree of nominal flexibility and a lower degree of real rigidity imply, *ceteris paribus*, a steeper Phillips curve and, thereby, a stronger response of inflation to demand pressures.

Where does convexity come from? Convexity is introduced into equation (A.10) when the parameters that determine the short-run trade-off between inflation and unemployment are variables that change with labour market conditions. For example, if the degree of real wage rigidity is a positive function of the unemployment level, then the Phillips curve would exhibit convexity. MM3 assumes that such function is of linear form, such that $1/(\alpha_1 + \delta_1) = f(u) = \Omega u - \Theta$. Under these circumstances, equation (A.10) becomes:

$$\pi_t = \lambda_1 \pi^e + (1 - \lambda_1) \pi_{t-1} + \frac{\lambda_1}{\Omega} \frac{(u^* - u)}{(u - \Theta/\Omega)} \quad (\text{A.11})$$

which is exactly the same as equation (6.2) in the text where $\gamma = \lambda_1/\Omega$ and $\phi = \Theta/\Omega$. Note that both increases in nominal flexibility and falls in real rigidity raises the coefficient γ in

(6.2). Why should real wage rigidity increase in the face of higher unemployment levels? Explanation is provided by several theoretical labour market models. Efficiency-wage models *à la* Shapiro and Stiglitz (1984), where unemployment operates as a 'worker discipline device', are just an example. Evans (1985), with a disaggregate model of bottlenecks across different labour markets, is also able to derive a non-linear relationship between inflation and aggregate demand pressure.

Chapter Seven

Conclusions

In these pages I have shown by a number of examples that macroeconomic models still have an important role to play in policy analysis. In particular, they appear to be able to provide a consistent quantitative framework in which to test alternative policies. To accomplish such duty, macroeconomic models must be based on adequate empirical performances and, at the same time, contain a theoretically consistent account of agents' behaviour. Yet, these are necessary but not sufficient conditions in policy design and evaluation. Especially in cases where the assessment of future policy innovations is at question, the Lucas critique bites quite hard and consistency with historical data may then not be enough. These are areas where great care has to be taken in interpreting models' results in order to judge the role of additional assumptions made off-model. In these cases, macromodels should perhaps be viewed as a framework for investigating the macroeconomic consequences of a range of alternative scenarios. However, to distinguish among them, a further (and unavoidable) discretionary judgement is certainly required. The political element of any policy decision should, therefore, never be overlooked and 'policy evaluation with

macroeconomic models' should never be regarded as a synonym of 'ready-to-be-implemented recipe'.

A number of cases have been presented throughout this thesis, where macroeconomic models are employed as useful tools for evaluation of contemporary policy problems. A range of alternative approaches has been proposed to shed light on how macromodels can actually contribute to the policy debate. In particular, I have emphasised how different models may be augmented or modified and stress the need for care in the experimental design of policy simulations. At the same time, relevant policy implications have been drawn throughout such model-based analyses. Let us recap the main findings.

Small stylised models of the UK economy are estimated in the first part of this thesis. They are used to assess the performance of simple monetary policy rules under the current inflation targeting monetary regime. In a monetary policy regime of inflation targeting, the objective is typically specified as a range of outcomes for future inflation. Since monetary policy affects inflation with a lag, current policy is set in relation to forecasts of future inflation; since forecasts are subject to error, point targets will almost always be missed, and an indication of the inherent uncertainty is given by a target band. The approach used in chapter 2 to the determination of an appropriate band width is to build a macroeconomic model of the economy and then use suitable analytical techniques to assess the variance of inflation under alternative policy reactions to shocks. An influential study recently published by the Bank of England (Haldane and Salmon, 1995) estimates a 'small semi-structural model' of the inflation process with backward-looking expectations, and uses stochastic simulation techniques to calculate the variance of inflation under simple feedback rules for interest rates. The study's most striking conclusion is that there exists 'a fairly substantial lump of inflation uncertainty' in the United Kingdom. Specifically, their results imply that there is 'on average, a no better than one in four probability of hitting a 1%-4% inflation target'. Comparing results in chapter 2 with the original Haldane and Salmon's results, we see that incorporating the exchange-rate transmission channel and an explicit forward-looking treatment of expectations

reduces the estimated standard deviation of inflation to approximately 50 per cent of their figures. Calibrating the variances and covariances of random disturbances to the experience of only the last decade of their sample achieves a further reduction of a little more than one-half. The lump of inflation uncertainty is thus substantially reduced. One contribution to this improvement comes from the recognition that the underlying variance or uncertainty of inflation has fallen as the level of inflation has fallen, and further reductions could also be appropriate as central bank credibility has increased out-of-sample. Also contributing are the extensions allowed to their model, endogenizing the exchange rate and treating expectations in an explicit forward-looking manner. These extensions are kept to a minimum, since the present purpose is to confront the 'substantial lump of inflation uncertainty' on its home ground of a small stylised model of the inflation process; this also permits to deploy recently-developed analytic techniques for linear rational expectations models. There are, nevertheless, other relevant features which are commonplace in leading structural models of the UK economy but are still missing from the small stylised model used in chapter 2: for instance, an explicitly forward-looking behaviour in price and wage determination and a more complete integration of steady-state properties and short-run dynamic adjustments, through the use of error-correction models. These extensions are considered in chapter 3 together with a wider range of policy rules, including 'inflation forecast targeting' à la Svensson (1997, 1999) and 'Taylor' rules. In this chapter different degrees of forward-lookingness in both inflation targeting horizon and wage bargaining are also taken into account. Linearity and analytical tractability of the empirical model are, however, retained. In this way, the extension of Blanchard and Kahn's (1980) solution method for rational expectations models deployed in chapter 2 can be used here to calculate the variances of inflation and output. Within the model, we give particular relevance to the determination of wages and prices, reflecting the substantial developments in this area in the last decades. Careful attention is granted to both statistical and economic issues, by recognising the need to go beyond single-equation modelling and the policy implications of the empirical study. The major conclusion of our analysis concerns the central role that credibility is found to play when stabilisation goals are

at issue. Specifically, forward-lookingness in labour and foreign markets is likely to have a crucial impact on the effectiveness of monetary policy, whereas the choice of which inflation targeting horizon does not seem to make much difference. Once credibility of the new policy regime is taken into account, our estimates indicate about 1% standard error for annual inflation, in line with the findings in the previous chapter. This implies that a tolerance interval of plus or minus one percentage point can be achieved approximately two-thirds of the time, compared with Haldane and Salmons' argument for an inflation target band width "at least as large as the three percentage points [then] operating in the United Kingdom - and possibly much wider". This value also represents a reduction of approximately one-half of the corresponding estimate of inflation volatility provided by Bean (1998) for comparable policy objectives in a much simpler model. Our results, however, provide support to Bean's evidence of rectangularity of inflation-output standard error trade-offs. The lowest bound for inflation variability is in fact found to be couple, over the relevant period, with a ceiling for output volatility. This means that beyond a certain point, further tightening of the monetary policy cannot induce any better inflation control. At the same time, if some weight is to be placed on output variability, then stronger signals of inflation control have also to be sent to the market, to make an inflation target monetary policy effective.

The remainder of the thesis concentrates upon monetary transmission mechanisms, though from a number of different perspectives. Large-scale country models have the convenience to make explicit a complete range of relationships among macroeconomic variables most of which, for obvious reasons, are neglected in smaller dynamic models. As a consequence, such quantitative framework offers an unique opportunity to evaluate not only the aggregate impact of exogenous shocks on the variables of interest, but also to identify the underlying economic mechanisms enabling the transmission of such shocks. In the second part of the thesis, I undertake simulations of the National Institute's Domestic Econometric Model (NIDEM) to analyse the characteristics of the UK monetary transmission mechanism. Chapter 4 emphasises that the impact of interest rate movements on real variables is strictly determined

by both the monetary regime at work and the underlying assumptions regarding consumption behaviour. Specifically, under the model's default consumption specification, based on the so called 'disposable funds' approach, UK real output and its components are found to be highly sensitive to monetary policy disturbances. Interest rate sensitivity even increases when an inflation targeting rule is replaced by a pegged exchange rate regime. However, if households are assumed to make their spending decisions within a life-cycle perspective while 'excessively' discounting the future, then the interest rate sensitivity of consumption falls dramatically. Moreover, decomposing GDP responses by transmission channels shows that monetary policy exerts a strong influence on spending components *via* its impact on the fiscal stance, particularly under a fixed exchange rate regime. Because of the sluggish debt reabsorption characterising the model, its effect appears to be more pronounced in the medium-to-long run. Given the decentralised nature of fiscal policy and fiscal structures within EMU, evidence of a quantitatively important fiscal channel of monetary policy is likely to weaken the argument for a symmetric policy response to a common change in the policy rate.

Certainly, the steady integration of the members of the EMU and increasing awareness of the need for closer co-operation in monetary and fiscal policy have stimulated greater interest in modelling interdependencies between European countries and the impact and feedbacks from the rest of the world economy. Many of the key issues have now an international aspect, so it becomes more and more difficult to rely on single-country models to provide necessary analysis. International transmission mechanisms can therefore be better tackled with a multi-country model. The third and last part of this thesis focuses on cross-country asymmetric transmissions in response to a common monetary shock within EMU. In particular, in chapter 5 an empirical analysis of the links between monetary and fiscal policy within EMU is presented. This is done through simulations of a neo-classical multi-country model: the IMF's MULTIMOD Mark III (MM3). In MM3 monetary policy has a quasi-fiscal dimension, since money both enters the government budget constraint and affects real wealth. Each European

economy is characterised - even in steady state - by a different debt/money composition of deficit financing and assumed to sustain it by running a different primary surplus. This allows to assess the effects of a common monetary policy on country-specific fiscal stances as well as the implications of enforcing a Stability and Growth Pact in equilibrium and during transition to the new steady state. To investigate asymmetric monetary transmissions within Monetary Union among Germany, France and Italy only, I first simulate a permanent fully credible reduction in the EMU-3 money supply target under the assumption that an independent ECB is adjusting short-term policy rate to reduce aggregate money supply to the new target. This experiment represents the benchmark scenario: under these circumstances asymmetries are temporary and almost entirely driven by dissimilarities in the structure of national labour markets. I thus repeat the experiment under alternative model assumptions, namely: (i) a common rate of money financing, as a result of the centralisation of seigniorage revenues under EMU; (ii) a strict enforcement of the SGP, ensuring that Maastricht criteria will be met by all European countries, at least in steady state; (iii) more efficient credit markets all over the Euro area. Given the static homogeneity characterising MM3, any evidence of long-run real effects following a permanent reduction in money supply is namely to be associated with the so-called 'fiscal dimension' of monetary policy. Simulation results largely support my a-priori. Centralising money supply seems to induce long-term cross-country wealth redistribution in response to a common monetary shock, unless accompanied by offsetting country-specific corrections in their debt stocks. Although the convergence criteria implicit in the Stability Pact are not necessary in MM3 to ensure fiscal sustainability, their strict enforcement is shown to be associated with overall ever-lasting benefits. Transition to the new steady state appears, however, remarkably costly for high-debt EMU countries. Reducing credit market imperfections is not found to alleviate such transition costs. Besides, different degrees of borrowing constraints across Europe are per se unlikely to explain cross-country heterogeneity in monetary transmission.

Chapter 6 provides further evidence about the effects of embracing a Monetary Union when underlying macroeconomic structures still differ across countries. By use of the same model-based quantitative framework, this chapter examines the role of nominal and real rigidities in European labour markets for the assessment of alternative monetary regimes. Meanwhile, it answers a number of relevant questions. Is the choice of a particular monetary arrangement neutral with respect to the degree of asymmetry in policy responses across countries? Can labour market discipline favour convergence? Is labour market flexibility always good news? I show that under EMU, overall responses to symmetric monetary shocks appear to be weaker, as cross-border exchange-rate fluctuations are internalised and monetary cooperation is institutionally enforced. This may render the degree of cross-country heterogeneity less evident, at least with respect to the more rigid economies of the Euro-zone. However, for countries characterised by higher (nominal and real) flexibility in their economic structure, EMU is only desirable if compared with the old ERM regime, while it induces policy overreaction with respect to uncoordinated monetary stances. In this way, EMU could widen the gap between rigid and flexible European economies. Secondly, different extant economic conditions are liable to represent further barriers to the process towards convergence. Finally, although in the presence of inflation inertia and non-linear short-run constraints different degrees of rigidity in national labour markets are sufficient to undermine synchronisation in the business cycle, labour market discipline is not likely to ensure convergence on its own. In particular, as responsiveness to monetary changes is significantly greater, *ceteris paribus*, in high-debt countries, the chapter argues that allowing for greater nominal and real flexibility in these labour markets may boost fluctuations in real aggregates, thereby inducing destabilising effects in the economy. This seems to suggest a clear ordering in the sequence of structural reforms these countries need to undertake, with fiscal consolidation being the *sine qua non* to any subsequent labour market reform. In this respect, our results provide support to Burda's (1999) conclusion that '[c]alls for additional may be the economic equivalent of whipping a dead horse, and could provoke counterproductive reactions'.

It should then be clear that besides providing a quantitative assessment of highly debated up-to-date policy issues, the previous discussion emphasises the role of models as a tool of thought, rather than as a black box. In order to 're-conquer' policy-makers' trust in macromodels, these need in fact to be applied carefully and interpretation of their findings require an investment of intellectual effort. Probably the main mistake which has been committed in the past decades has been to see them as mechanical devices, able to provide a short-cut to answering questions about national or international economic policy. This is never the case. In order to use macromodels properly, it is necessary that they are adequate for the desired purposes. If they are not, then they should be modified without forcing results which have no supporting evidence. Since each model is constructed a specific purpose, then different modelling approaches should be seen as complements, whereas a rigid obedience to a single model is not a sensible strategy. This thesis is an example of such eclectic way of using macromodels for policy evaluation. Since flexibility and transparency should be reckoned as the ultimate goals of any policy analysis, the tools of such analysis should also be flexible and transparent. Opening models up to policy-makers and revealing where judgement is needed, may then be likely to encourage their further use.

REFERENCES

- Alesina, A., and V. Grilli, 1992, The European Central Bank: Reshaping Monetary Politics in Europe, in *Establishing a Central Bank: Issues in Europe and Lessons from the US*, M. Canzoneri, V. Grilli and P. Masson (eds.), Cambridge University Press.
- Allsopp, C. and D. Vines, 1998, The Assessment: Macroeconomic Policy after EMU, *Oxford Review of Economic Policy*, 14, 1-23.
- Alogoskoufis, G. and R. Smith, 1991, The Phillips Curve, the Persistence of Inflation, and the Lucas Critique: Evidence from Exchange Rate Regimes, *American Economic Review*, 81, 1254-75.
- Artis, M.J. and P. Omerod, 1996, Is There an EMS Effect in European Labour Markets?, *CEPR*, discussion paper no. 598.
- Artus, J. and M. Salomon, 1996, The EMS, Credibility and Disinflation: The French Case, in P. De Grauwe, S. Micossi and G. Tullio (eds.), *Inflation and Wage Behaviour in Europe*, Clarendon Press, Oxford, 30-58.
- Ball, L., 1994, Credible Disinflation with Staggered Price-Setting, *American Economic Review*, 84, 282-90
- Ball, L., 1997, Efficient Rules for Monetary Policy, *National Bureau of Economic Research*, working paper no. 5952, Cambridge, Mass.
- Barber, T., 2000, Problem: How to Get the New Europe to Work, *Financial Times*, 6th April.
- Barro, R.J. and D. Gordon, 1983, Rules, Discretion and Reputation in a Model of Monetary Policy, *Journal of Monetary Economics*, 12, 101-21.
- Bartolini, L., Razin, A. and S. Symansky, 1995, G-7 Fiscal Restructuring in the 1990s: Macroeconomic Effects, *Economic Policy*, 20, 111-46.
- Bayoumi, T. and D. Laxton, 1994, Government Deficits, Debt, and the Business Cycle, in *Deficit Reduction - What Pain, What Gain?*, W. Robson and W. Scarth (eds.), C.D. Howe Institute.
- Bean, C.R., 1998, The New UK Monetary Arrangements: a View from the Literature. *Economic Journal*, 108, 1795-1809.
- Beetsma, R. and H. Uhlig, 1999, An Analysis of the Stability and Growth Pact, *Economic Journal*, 109, 546-71
- Begg, D., De Grauwe, P., Giavazzi, F., Uhlig, H. and C. Wyplosz, 1998, "The ECB: Safe at Any Speed?", *Monitoring the European Central Bank 1*, CEPR, London.
- Bernanke, B.S. and M. Gertler, 1995, Inside the Black Box: The Credit Channel of Monetary Policy Transmission, *Journal of Economic Perspectives*, 9(4), 27-48.
- BIS (Bank of International Settlement), 1995, *Financial Structure and the Monetary Policy Transmission Mechanism*, Basle, BIS.

- Blake, A.P., 1996, Forecast Error Bounds by Stochastic Simulation. *National Institute Economic Review*, no.156, 72-79.
- Blake, A.P. and P.F. Westaway, 1996, Credibility and the Effectiveness of Inflation Targeting Regimes. *The Manchester School*, 64 (supplement), 28-50.
- Blanchard, O.J., 1984, Current and Anticipated Deficits, Interest Rates and Economic Activity, *European Economic Review*, 25, 7-27.
- Blanchard, O.J., 1985, Debt, Deficits and Finite Horizons, *Journal of Political Economy*, 93, 223-47.
- Blanchard, O.J. and C.M. Kahn, 1980, The Solution of Linear Difference Models under Rational Expectations. *Econometrica*, 48, 1305-1311.
- Blanchard, O.J. and L.F. Katz, 1997, What We Know and What We Do Not Know about the Natural Rate Model, *Journal of Economic Perspectives*, 51-72.
- Blinder, A.S., 1998, *Central Banking in Theory and Practice*, MIT, Cambridge, Mass.
- Bolt, W., 1999, Fiscal Restarints, ECB Credibility and the Stability Pact: A Game-Theorethic Perspective, De Nederlandsche Bank, *DNB Staff Reports*, no. 38.
- Borio, C.E.V., 1997, Credit Characteristics and the Monetary Policy Transmission Mechanism in Fourteen Industrial Countries, in K. Alders (ed.), *Monetary Policy in a Converging Europe*, Amsterdam, Kluwer.
- Breedon, F.J. and P.G. Fisher, 1993, M0: Causes and Consequences, working paper no.20, *Bank of England*.
- Britton, E. and J. Whitley, 1997, Comparing the Monetary Transmission Mechanism in France, Germany and the United Kingdom: Some Issues and Results, *Bank of England Quarterly Bulletin*.
- Broer, P., N. Draper, and F. Huizinga, 1999, The Equilibrium Rate of Unemployment in the Netherlands, *Centraal Planbureau*, The Hague, Research Memorandum no. 156.
- Brown, B.W., and S. Maital, 1981, What Do Economists Know? An Empirical Study of Experts' Expectations, *Econometrica*, 49, 491-504.
- Bryant, R.C., Henderson, D.W., Holtham, G., Hooper P. and S. Symansky, (eds), 1988, *Empirical Macroeconomics for Interdependent Economies*. Washington DC: Brookings Institution.
- Bryant, R.C., Hooper, P. and C.L. Mann, (eds), 1993, *Evaluating Policy Regimes: New Research in Empirical Macroeconomics*. Washington DC: Brookings Institution.
- Brayton, F., Levin, A., Tryon, R. and J.C. Williams, 1997, The Evolution of Macro Models at the Federal Reserve Board. *Carnegie-Rochester Conference Series on Public Policy*, 47, 43-81.
- Buiter, W. H., 1995, Macroeconomic Policy During a Transition to Monetary Union, *CEPR*, discussion paper no. 1222.
- Buiter, W., Corsetti, G. and N. Roubini, 1993, Excessive Deficits: Sense and Nonsense in the Treaty of Maastricht, *Economic Policy*, 16, 57-100.

- Burda, M.C., 1999, European Labour Markets and the Euro: How Much Flexibility Do We Really Need, *CEPR*, discussion paper no. 2217.
- Buti, M., Franco, D. and H. Ongena, 1998, Fiscal Discipline and Flexibility in EMU: The Implementation of the Stability and Growth Pact, *Oxford Review of Economic Policy*, 14(3), 81-97.
- Buttiglione, L. and G. Ferri, 1994, Monetary Policy Transmission via Lending Rates in Italy: Any Lessons from Recent Experience?, *Temi di Discussion del Servizio Studi*, 224, Banca d'Italia.
- Calmfors, L., 1998, Macroeconomic Policy, Wage Setting and Employment – What Difference Does EMU Make?, *Oxford Review of Economic Policy*, 14, 125-51.
- Calmfors, L. and J. Driffill, 1988, Bargaining Structure, Corporatism, and Macroeconomic Performance, *Economic Policy*, 6, 14-61.
- Carlin, W. and D. Soskice, 1990, *Macroeconomics and the Wage Bargain*, Oxford University Press, Oxford.
- Cavelaars, P.A.D., 1999, EMU, Monetary Policy Interactions and Exchange Rate Stability, *De Nederlandsche Bank*, MEB-series no. 17.
- Cecchetti, S.G., 1995, Distinguishing Theories of the Monetary Transmission Mechanism, *Federal Reserve Bank of St. Louis Review*, 77, 83-97.
- Cecchetti, S.G. and M. Ehrmann, 1999, Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers Preferences and Outcomes, *National Bureau of Economic Research*, working paper no. 7426.
- Chadha, B., P. Masson, and G. Meredith, 1992, Models of Inflation and the Costs of Disinflation, *IMF, Staff Papers*, 39, 395-431.
- Chan, A., Savage, D. and R. Whittaker, 1995, The New Treasury Model. *Government Economic Service* working paper no.128. London: HM Treasury.
- Christ, C.F., 1968, A Simple Macroeconomic Model with a Government Budget Restraint. *Journal of Political Economy*, 76, 53-67.
- Church, K.B., Mitchell, P.R., Smith, P.N. and K.F. Wallis, 1996, Targeting Inflation: Comparative Control Exercises on Models of the UK Economy, *Economic Modelling*, 13, 169-184.
- Church, K.B., Mitchell, P.R., Sault, J.E. and K.F. Wallis, 1997, Comparative Properties of Models of the UK Economy, *National Institute Economic Review*, no.161, 91-100.
- Church, K.B., Sault, J.E., Sgherri, S. and K.F. Wallis, 2000, Comparative Properties of Models of the UK Economy, *National Institute Economic Review*, no.164, 106-22.
- Church, K., P. Smith and K.F. Wallis, 1994, Econometric Evaluation of Consumers Expenditure Equations, *Oxford Review of Economic Policy*, 10(2), 71-85.
- Clark, P.B. and D. Laxton, 1997, Phillips Curves, Phillips Lines and the Unemployment Costs of Overheating, *IMF*, working paper 97/17.

- Clarida, R., Gali, J. and M. Gertler, 1998, Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory, *CEPR*, discussion paper no. 1908, Cambridge, Mass.
- Clarida, R., Gali, J. and M. Gertler, 2000, Monetary Policy Rules in Practice: Some International Evidence, *Quarterly Journal of Economics*, 147-80.
- Cuckierman, A. and F. Lippi, 1999, Central Bank Independence, Centralization of Wage Bargaining, Inflation and Unemployment – Theory and Some Evidence, *European Economic Review*, 43, 1395-434.
- Cuckierman, A. and F. Lippi, 2000, Labor Markets and Monetary Union: A Strategic Analysis, *Banca d'Italia*, Temi di Discussione series.
- Currie, D. and P. Levine, 1993, *Rules Reputation and Macroeconomic Policy Coordination*, Cambridge University Press, Cambridge.
- Dale, S. and A. Haldane, 1995, Interest Rate and the Channels of Monetary Transmission: Some Sectoral Estimates, *European Economic Review*, 16, 177-92.
- Darby, J. and J. Ireland, 1994, Consumption, Forward-looking Behaviour and Financial Deregulation, *International Centre for Macroeconomic Modelling*, discussion paper 20.
- De Bondt, G.J., 2000, *Financial Structure and Monetary Transmission in Europe: A Cross-Country Study*, Edward Elgar, Cheltenham.
- Deaton, A. S., 1992, *Understanding Consumption*, Oxford, Oxford University Press.
- Debelle, G. and D. Laxton, 1997, Is the Phillips Curve Really a Curve? Some Evidence for Canada, the United Kingdom and the United States, IMF, *Staff Papers*, 44, 249-82.
- Demertzis, M., A. Hughes-Hallett, and N. Viegi, 1999, An Independent Central Bank with Elected Governments: A Political Economy Conflict, *CEPR*, discussion paper no. 2219.
- Detken, C., 1999, Fiscal Policy Effectiveness and Neutrality Results in a Non-Ricardian World, *ECB*, working paper 3.
- Dhar, S.K., Fisher, P.G., Holland, A.M. and D.L. Pain, 1995, Interest Rate Effects in the Bank of Englands Medium-Term Forecasting Model, in *Financial Structure and the Monetary Policy Transmission Mechanism*, 537-562, Basle: Bank for International Settlements.
- Dornbusch, R., C. Favero and F. Giavazzi, 1998, Immediate Challenges for the European Central Bank: Issues in Formulating a Single Monetary Policy, *Economic Policy*, 26, 15-64.
- EC Commission, 1990, One Market, One Money, *European Economy*, 44.
- Eichengreen, B., 1998, European Monetary Unification: A *Tour d'Horizon*, *Oxford Review of Economic Policy*, 14, 24-40.
- Eichengreen, B. and C. Wyplosz, 1998, The Stability Pact: More than a Minor Nuisance?, *Economic Policy*, 26, 65-114.
- Eijffinger, S. and J. de Haan, 1995, The Political Economy of Central Bank Independence, *CentER* discussion paper no. 9587, Tilburg University, The Netherlands.

- Engle, R.F. and C.W.J. Granger, 1987, Co-integration and Error Correction: Representation, Estimation, and Testing, *Econometrica*, 55, 251-276.
- Evans, G., 1985, Bottlenecks and the Phillips Curve: A Disaggregated Keynesian Model of Inflation, Output and Unemployment, *Economic Journal*, 95, 345-57.
- Faruquee, H., D. Laxton, and S. Symansky, 1997, Government Debt, Life-Cycle Income and Liquidity Constraints: Beyond Approximate Ricardian Equivalence, IMF, *Staff Papers*, 44, 374-82.
- Friedman, M., 1968, The Role of Monetary Policy, *American Economic Review*, 58, 1-17.
- Friedman, M., 1977, Nobel Lecture: Inflation and Unemployment, *Journal of Political Economy*, 85, 451-472.
- Fuhrer, J.C., 1997, Inflation/Output Variance Trade-Offs and Optimal Monetary Policy, *Journal of Money, Credit and Banking*, 29, 214-34.
- Fuhrer, J.C. and G.R. Moore, 1995, Inflation Persistence, *Quarterly Journal of Economics*, 110, 127-59.
- Gerlach, S. and F. Smets, 1995, The Monetary Transmission Mechanism: Evidence from the G-7 Countries, in *Financial Structure and the Monetary Policy Transmission Mechanism*, Basle, BIS.
- Giavazzi, F. and A. Giovannini, 1986, The EMS and the Dollar, *Economic Policy*, 2, 455-85.
- Giavazzi, F. and M. Pagano, 1988, The Advantage of Tying One's Hands: EMS Discipline and Central Bank Credibility, *European Economic Review*, 32, 1055-82.
- Gonzalo, J. and T.H. Lee, 1998, Pitfalls in Testing for Long-run Relationships, *Journal of Econometrics*, 86, 129-154.
- Goodhart, C.A.E. and J. Viñals, 1994, Strategy and Tactics of Monetary Policy: Examples From Europe and the Antipodes, in *Goals, Guidelines and Constraints Facing Monetary Policymakers* (J.C. Fuhrer, ed.), 139-187. Conference Series no.38, Federal Reserve Bank of Boston.
- Graafland, J.J., 1992, From Phillips Curve to Wage Curve, *De Economist*, 140, 501-515.
- Gressani, D., L. Guiso, and I. Visco, 1988, Disinflation in Italy: An Analysis with the Econometric Model of the Banca d'Italia, *Journal of Policy Modeling*, 8, 163-203.
- Hacche, G., 1974, The Demand for Money in the United Kingdom: Experience Since 1971, *Bank of England Quarterly Bulletin*, 14, 284-305.
- Haldane, A.G., 1995, Inflation Targets, *Bank of England Quarterly Bulletin*, 35, 250-259.
- Haldane, A.G. and N. Batini, 1998, Forward-Looking Rules for Monetary Policy, *National Bureau of Economic Research*, working paper no. 6543, Cambridge, Mass.
- Haldane, A.G. and C.K. Salmon, 1995, Three Issues on Inflation Targets, in *Targeting Inflation* (A.G. Haldane, ed.), 170-201. London: Bank of England.

Hall, S.G. and A. Garratt, 1992, Model Consistent Learning: The Sterling-Deutschmark Rate in the London Business School Model, *CEF*, discussion paper 02-92, London Business School.

Hansen, L.P., 1982, Large Sample Properties of Generalised Method of Moments Estimation, *Econometrica*, 50, 1029-54.

Hayashi, F., 1982, The Permanent Income Hypothesis: Estimation and Testing by Instrumental Variables", *Journal of Political Economy*, 90, 895-916.

Hendry, D.F. and G.E. Mizon, 1978, Serial Correlation as a Convenient Simplification, not a Nuisance: a Comment on a Study of the Demand for Money by the Bank of England, *Economic Journal*, 88, 549-563.

Herrendorf, B., 1998, Inflation Targeting as a Way of Precommitment, *Oxford Economic Papers*, 50, 431-448.

Hochreiter, E. and G. Winckler, 1995, The Advantages of Tying Austrias Hands: The Success of the Hard Currency Strategy, *European Journal of Political Economy*, 11, 83-111.

Hughes Hallett, A., L. Piscitelli, and T. Warmendiger 1998, On the Asymmetric Impacts of a Common Monetary Policy in Europe, *The International Centre for Macroeconomic Modelling*, University of Strathclyde, discussion paper no. 52.

IMF, 1997, *World Economic Outlook*, October, Annex II.

Jappelli, T. and M. Pagano, 1989, Consumption and Capital Market Imperfections: An International Comparison, *American Economic Review*, 79, 1088-105.

Jeanne, O., 1997, Generating Real Persistent Effects of Monetary Shocks: How Much Nominal Rigidity Do We Really Need?, *CEPR*, discussion paper no. 6258.

Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control*, 12, 231-254.

Joyce, M. and S. Wren-Lewis, 1991, The Role of the Exchange Rate and Capacity Utilisation in Convergence of the NAIRU, *Economic Journal*, 101, 497-507.

Juillard, M., Laxton, D., McAdam, P. and H. Pioro, 1999, Solution Methods and Non-Linear Forward-Looking Models, in A. Hughes-Hallett and P. McAdam (eds.), *Analyses in Macroeconomic Modelling*, Kluwer Academic Publishers.

Kremers, J.J.M., 1990, Gaining Policy Credibility for a Disinflation, IMF, *Staff Papers*, 37, 116-45.

Layard, P.R.G. and S.J. Nickell, 1985, The Causes of British Unemployment, *National Institute Economic Review*, 111, 62-85.

Layard, P.R.G. and S.J. Nickell, 1986, Unemployment in Britain, *Economica* (supplement), S3, S121-S169.

Layard, P.R.G., S.J. Nickell, and R.A. Jackman, 1991, *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press, Oxford.

Laxton, D., P. Issard, H. Faruquee, E. Prasard, and B. Turtleboom, 1998, MULTIMOD Mark III: The Core Dynamic and Steady State Models, *IMF*, Occasional Paper no. 167.

- Laxton, D., G. Meredith, and D. Rose, 1995, Asymmetric Effects of Economic Activity on Inflation: Evidence and Policy Implications, IMF, *Staff Papers*, 42, 344-74.
- Laxton, D., D. Rose, and D. Tambakis, 1999, The US Phillips Curve: The Case for Asymmetry, *Journal of Economic Dynamics and Control*, 23, 1459-85.
- Leith, C. and S. Wren-Lewis, 1997, Interest Rate Feedback Rules in an Open Economy with Forward-Looking Inflation, working paper, University of Exeter.
- Levin, A., Wieland, V. and J.C. Williams, 1998, Robustness of Simple Monetary Policy Rules under Model Uncertainty, *National Bureau of Economic Research*, working paper no. 6570 Cambridge, Mass.
- MacLennan, D., J. Muellbauer and M. Stephens, 1998, Asymmetries in Housing and Financial Market Institutions and EMU, *Oxford Review of Economic Policy*, 14(3), 54-80.
- Manning, A., 1992, Productivity Growth, Wage Setting and the Equilibrium Rate of Unemployment. *Centre for Economic Performance*, discussion paper no.63., London School of Economics.
- Masson, P.R. and S. Symansky, 1992, Evaluating the EMS and EMU Using Stochastic Simulations: Some Issues, in *Macroeconomic Policy Co-ordination in Europe*, R. Barrell and J. Whitley (eds.), Sage.
- Masson, P. and M. Taylor, 1993, Fiscal Policy with Common Currency Areas, *Journal of Common Market Studies*, 31, 29-44.
- McCallum, B.T., 1995, Two Fallacies Concerning Central Bank Independence, *American Economic Review*, Papers and Proceedings, 85, 207-11.
- McCallum, B.T., 1997, Crucial Issues Concerning Central Bank Independence, *Journal of Monetary Economics*, 39, 99-112.
- Meltzer, H.A., 1995, Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective, *Journal of Economic Perspectives*, 9(4), 49-72.
- Millard, S.P., 2000, The Effects of Increased Labour Market Flexibility in the United Kingdom: Theory and Practice, *Bank of England*, working paper series.
- Miller, M.H. and A. Sutherland, 1991, The Walters Critique of the EMS - A Case of Inconsistent Expectations?, *The Manchester School*, 59 (supplement), 23-37.
- Minford, P. and A. Rastogi, 1990, The Price of EMU, in R. Dornbusch and R. Layard (eds.), *Britain and EMU*, CEPR, London.
- Minford, P., A. Rastogi, and A. Hughes Hallett, 1993, The Price of EMU Revisited, *Greek Economic Review*, 15(1), 191-226.
- Mitchell, P.R., Sault, J.E., Smith, P.N. and Wallis, K.F., 1998, Comparing Global Economic Models, *Economic Modelling*, 15, 1-48.
- Mitchell, P.R., Sault, J.E. and Wallis, K.F., 2000, Fiscal Policy Rules in Macroeconomic Models: Principles and Practice, *Economic Modelling*, 17, 171-93.
- Muellbauer, J., 1994, The Assessment: Consumer Expenditure, *Oxford Review of Economic Policy*, 10(2), 1-41.

- Muellbauer, J. and R. Lattimore, 1995, The Consumption Function: A Theoretical and Empirical Overview, in M. H. Pesaran and M. Wickens (eds), *Handbook of Applied Econometrics*, Oxford, Blackwells.
- Muellbauer, J. and A. Murphy, 1993, Income expectations, Wealth and Demography in the Aggregate US Consumption Function, *H.M. Treasury Academic Panel*, AP(93), 4.
- Muellbauer, J. and A. Murphy, 1997, Booms and Busts in the UK Housing Market, *Economic Journal*, 107, 1701-27.
- NIESR (National Institute of Economic and Social Research), 1999, *National Institute Domestic Econometric Model Manual*, London, NIESR, January 1999.
- Obstfeld, M. and K. Rogoff, 1995, The Mirage of Fixed Exchange Rate, *Journal of Economic Perspectives*, 9(4), 73-96.
- Obstfeld, M. and G. Peri, 1998, Regional non-Adjustment and Fiscal Policy, *Economic Policy*, (special issue), 26, 205-260.
- Obstfeld M. and K. Rogoff, 1996, *Foundation of International Macroeconomics*, MIT Press, Cambridge, MA.
- Oudiz, G. and J. Sachs, 1984, Macroeconomic Policy Co-ordination Among the Industrial Economies, *Brookings Papers on Economic Activity*, 1, 1-64.
- Pain, N. and P. Westaway, 1994, Housing Consumption and Borrowing: An Econometric Model of Personal Sector Behaviour, NIESR, London, July 1994.
- Pagan, A.R., 1984, Econometric Issues in the Analysis of Regressions with Generated Regressors, *International Economic Review*, 25, 221-247.
- Reifschneider, D.L., Stockton, D.J. and D.W. Wilcox, 1997, Econometric Models and the Monetary Policy Process. *Carnegie-Rochester Conference Series on Public Policy*, 47, 1-37.
- Rogoff, K., 1985, The Optimal Degree of Commitment to an Intermediate Target, *Quarterly Journal of Economics*, 100, 1169-90.
- Rogoff, K., 1996, The Purchasing Power Parity Puzzle, *Journal of Economic Literature*, 34, 647-668.
- Rotemberg, J.J. and M. Woodford, 1998, Interest-rate rules in an estimated sticky price model, *National Bureau of Economic Research*, working paper no. 6618, Cambridge, Mass.,
- Rudebusch, G.D., 2000, Assessing Nominal Income Rules for Monetary Policy with Model and Data Uncertainty, *ECB*, working paper no. 14.
- Rudebusch, G.D. and L.E.O. Svensson, 1998, Policy Rules for Inflation Targeting, working paper no.6512, *National Bureau of Economic Research*, Cambridge, Mass.
- Sargent, T., and N. Wallace, 1981, Some Unpleasant Monetarist Arithmetic, reprinted in Sargent T. (1986), *Rational Expectations and Inflation*, chapter 5, 158-90.
- Shapiro, C. and J. Stiglitz, 1984, Equilibrium Unemployment as a Worker Discipline Device, *American Economic Review*, 72, 433-44.

Soskice, D. and T. Iversen, 2000, The Non-Neutrality of Monetary Policy with Large Price or Wage Setters, *Quarterly Journal of Economics*, 115, 265-84.

Svensson, L.E.O., 1997a, Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets, *European Economic Review*, 41, 1111-46.

Svensson, L.E.O., 1997b, Inflation Targeting: Some Extensions, working paper 5962, *National Bureau of Economic Research*, Cambridge, Mass.

Svensson, L.E.O., 1998a, Inflation Targeting as a Monetary Policy Rule, working paper no. 6790, *National Bureau of Economic Research*, Cambridge, Mass.

Svensson, L.E.O., 1998b, Open-Economy Inflation Targeting, discussion paper no. 1989, *CEPR*, London.

Svensson, L.E.O., 1999, Monetary Policy Issues for the Eurosystem, discussion paper no. 2197, *CEPR*, London.

Taylor, J.B., 1979, Estimation and Control of a Macroeconomic Model with Rational Expectations, *Econometrica*, 47, 1267-1286.

Taylor, J.B., 1993, Discretion versus Policy Rules in Practice, *Canergie-Rochester Conference Series on Public Policy* no. 39, 195-214.

Taylor, J.B., 1995, The Monetary Transmission Mechanism: An Empirical Framework, *Journal of Economic Perspectives*, 9(4), 11-26.

The Economist, 1999, Fiscal flexibility, 27/11/99, p. 100.

Turner, D., 1991, The Determinants of the NAIRU Response in Simulations on the Treasury Model, *Oxford Bulletin of Economic and Statistics*, 53, 225-42.

Young, G., 1997, The Long Term Benefits to the UK Economy of Low Inflation, *National Institute of Economic and Social Research*, December.

Wallis, K.F., 1993, On Macroeconomic Policy and Macroeconometric Models, *The Economic Record*, 69, 113-30.

Walsh, C., 1995, Optimal Contracts for Central Bankers, *American Economic Review*, 85, 150-67.

Walsh, C., 1998, *Monetary Theory and Policy*, MIT Press, Cambridge, MA.

Westaway, P.F., 1992, A Forward-Looking Approach to Learning in Macroeconomic Models, *National Institute of Economic Review*, 86-97.

Westaway, P.F., 1993, A Micro-to-Macro Model of Personal Sector Behaviour, *H.M. Treasury Academic Panel*, AP(93), 8.

Whitley, J.D., 1994, *A course in macroeconomic modelling and forecasting*, Harvester Wheatsheaf, New York

Whitley, J., 1997, Economic models and policy-making, *Quarterly bulletin*, Bank of England, 37(2), 163-73.

Winckler, G., Hochreiter, E., and P. Brandner, 1998, Deficits, Debt and European Monetary Union: Some Unpleasant Fiscal Arithmetic, in G. Calvo and M. King (eds.), *The Debt Burden and its Consequences for Monetary Policy*, International Economic Association, Conference Volume 118, Macmillan Press Ltd.

Wolf, M., 2000, In with a chance in Lisbon, *Financial Times*, 22nd March.

Woodford, M., 1998, Control of the Public Debt: A Requirement for Price Stability?, in G. Calvo and M. King (eds.), *The Debt Burden and its Consequences for Monetary Policy*, International Economic Association, Conference Volume 118, Macmillan Press Ltd.

Wouters, R. and M. Dombrecht, 2000, Model-Based Inflation Forecasts and Monetary Policy Rules, *National Bank of Belgium*, working papers research series no. 1.

Wren-Lewis, S., 1995, The Natural Rate in Empirical Macroeconomic Models, in R. Cross (ed.), *The Natural Rate of Unemployment. Reflections on 25 Years of the Hypothesis*, Cambridge University Press, Cambridge, UK.

Wren-Lewis, S., J. Darby, J. Ireland and O. Ricchi, 1996, The macroeconomic effects of fiscal policy: linking an econometric model with theory, *Economic Journal*, 106.

Wren-Lewis, S. *et al.*, 1998, *COMPACT Version 4.0. A Quarterly Model of the UK Economy*, model manual.